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ABSTRACT

Rocks, and the soil formed from rock, play a major role in determining such particulars as the type of crops that can be grown in a specific area and the type of housing that can be constructed. Also, rocks may supply fuel and building materials, and provide information about the history of an area. This unit is constructed to expose secondary students to the forces that have determined the topography of an area, data on and field experience in fossil collecting, variance of rocks and fossils in different areas and how this information affects the city dweller's life through such illustrative examples as zoning decisions and considerations in purchasing a home. Teaching aid materials include behavioral objectives of the unit, a suggested time line, suggested methodologies, lists of appropriate films and filmstrips, and suggested evaluative instruments. (MLB)

environmental education curriculum

ENVIRONMENTAL EDUCATION PROJECT
ESEA TITLE III, SECTION 306

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A unit developed by the Environmental Education Project Staff, April, 1973, and revised June, 1974, for secondary science students.

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GEOLOGY AND OUR ENVIRONMENT

The work presented or reported herein was performed pursuant to a grant from the United States Office of Education. However, the opinions and material expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

Geology and Our Environment

Foreword

Rocks, and the soil formed from rock, play a major role in determining the quality of life for both city and rural citizens. Depth to bed rock, topography, and soil type all help determine the crops to be grown, or the type of housing which can be constructed. In addition, rocks may supply fuel, building materials, and the information needed to help man interpret the geologic history of the area.

This module will expose students to some of the concepts which can help them purchase homes, understand the ideals behind zoning decisions, and pursue fossil hunting as a hobby or an academic pursuit.

The module focuses on four broad topics:

1) What forces have shaped the hills and formed the soils in our county?
2) What are the fossils found near Topeka?
3) How do the rocks and fossils of Kansas vary across the state?
4) How does geology affect the city dweller's life?

These topics are developed with class and individual activities, films, papers, and a trip to Calhoun Bluffs. The achievement of the stated goals is guided with behavioral objectives, teacher suggestions, and questions to the students with each activity, film, and paper. The achievement is measured with carefully written and evaluated tests based on the behavioral objectives.

Robert E. King

Robert E. King
Secondary Program Specialist

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The Environmental Education Project for the Topeka Public and Parochial Schools began operation June 29, 1971. The following individuals deserve recognition for the interest, time, and devotion they gave during the difficult stages of planning and writing the project proposal:

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Special recognition is given to the Board of Education for the Topeka Public Schools, who approved and are supporting this creative, exemplary, and innovative project.

My sincere gratitude is extended to the program specialists for their tireless efforts in developing this secondary module. Curriculum development and revision has extended the working days for these staff members. My personal thanks are given to Bob King, Glenn Clarkson, and Thad Whiteaker for an outstanding job.

Assistance given by Ellen Duncan, who helped develop much of the initial material, is gratefully acknowledged.

The enclosed curriculum is the result of input from the project's paraprofessionals (Norma Hurd, Marlys Strobel, Prue Hendrix, Lynn Wilkerson, and Sue Beattie), and many volunteers, science teachers, Community Council members, parents, students, and interested lay citizens.

With the deepest appreciation, I acknowledge the work of the secretarial team. The constant revision, pressures, deadlines, and demands for quality work were handled in a most outstanding manner by Dorothy Booher, Sue Beattie, Rita Dreiling, Joyce Hartman, T. W. Mack, and Linda Hough.

Donald French
Project Coordinator

TABLE OF CONTENTS

Geology and Our Environment

Module Goals: The module seeks to reinforce and expand knowledge in the following areas:

1) What forces have shaped the hills and formed the soils in our county?

2) What fossils are found near Topeka, and how do you find them?

3) How do rocks and fossils of Kansas vary across the state?

4) How does geology affect the city dweller's life?

USE OF TEACHING MATERIALS

The suggested time line for this module is provided to allow easier planning.

The "Module Materials List" indicates the supplies you need to obtain to teach the module.

Film descriptions describe suggested and optional films and filmstrips.

A brief summary of the development and use of the behavioral objectives proceeds the list of behavioral objectives which indicate the concepts and abilities that most of your class should gain from studying this module.

The posttest for this module is included with the correct answers circled. This allows you to see the types of questions keyed to the behavioral objectives. Please do not teach the questions, but use the behavioral objectives. Many objectives concern concepts which require interpretation and extrapolation. Teaching the test questions requires only rote memorization. Student pre and posttest results are reported using this form.

The rest of this manual contains the papers available in the student manual. Following each one of the student papers, you will find sheets of green paper. These pages contain: 1) behavioral objectives tied to the paper; 2) suggestions for presenting the papers; and 3) answers to the student self-test questions. Particular attention should be given to the film material <u>before</u> presenting the film.

SUGGESTED TIME LINE FOR MODULE ACTIVITIES

The time line below is written in the ideal sequence of events with the average time required for teaching each activity indicated in parentheses. The times, of course, will vary from class to class. The day, or days, planned for each activity may be noted in the blank spaces to the left of each paper to be used.

Day

Before the Field Trip

Arrange the field trip date with the project staff, and obtain the student pretests. Obtain approval for the field trip dates from the building principal (use Paper H-2). Invite him to visit the field trip.

> Schedule the film "Earth Science: Parade of Ancient Life" for day 2. Duplicate copies of H-3.

_____30 min. 1. Hand out student books, read, and discuss the "Introduction," Paper A. Send home parental permission sheets.

> Obtain a 16mm projector.

_____55 min. 2. Read Paper B, "Ancient Life" and view the film, "Earth Science: Parade of Ancient Life."

_____55 min. 3. Read Paper C, "Geology of Kansas."

_____55 min. 4. Read and discuss Paper D, "Calhoun Bluffs - A General Description."

_____55 min. 5. Read and discuss Paper E, "Fossils - What Made Them." Have a short drill on identification of the larger fossils.

Call the Environmental Education Office (357-0351, Ext. 28) to confirm arrangements for the substitute, the times of departure and number of students participating.

> Remind students to return parental permission slips and notify other teachers of the field trip. Duplicate F-7&8.

_____70 min. 6. Read and discuss Paper F, "Geological Description of Calhoun Bluffs." Use the transparencies in Appendix B to develop the concept of correlation of rock layers.

_____10 min. 7. Give students the appropriate set of field trip rules and regulations, as contained on Page H-4. Prepare your lesson plans for the substitute.

_____45 min. 8. Read and discuss Paper G, "Does Geology Affect Us?"

_____3 hours 9. Field trip - 3 hours. Give the substitute her instructions. Bring student permission slips on the trip with you.

_____30 min. 10. Review the field trip and module objectives using the behavioral objectives (pages 7-9).

_____30 min. 11. Give the post-module test. Fill out the unit evaluation forms, and return the tests and forms to the project office.

Module Materials List

The following list contains the materials which you could use to teach this module. The materials are organized in the sequence of use.

1. Teacher's Guide to the Module.
2. One "Geology and Our Environment" student booklet per student.
3. Three "Requests to the Principal for Field Trip" forms per trip. (Duplicate page H-2)
4. One "Parental Permission" sheet per student and 10 extra copies/class. (Duplicate page H-3)
5. One worksheet per student for Paper F, "A Geological Description of Calhoun Bluffs." (Duplicate pages F-7 and F-8)
6. One field trip worksheet per student. (Duplicate pages H-5, H-6)
7. Three correlation transparencies for use with Paper F, and an overhead projector.
8. Clipboards for the field trip will be supplied by the Outdoor-Environmental Education Project upon request.
9. Post-module teacher evaluation packet (to be returned).
10. Post-module tests and answer sheets.
11. Post-module test results.

Audio-Visual Supplies Needed

Only the film below is recommended for this module. This film may be obtained from the Topeka Public Schools Audio-Visual Department.

Earth Science: Parade of Ancient Life - color, 14 min. University of Indiana

Examines the evidence concerning the origin and development of living forms, providing a general framework for fossil study and for the appreciation of earth history and paleontology as fields of investigation. Film shows specimens, reconstructions, and dioramas representing typical life forms in Paleozoic, Mesozoic, and Cenozoic eras. Surveys the evidence for organic evolution and changes in climate and landforms. Shows the relationship of ancient life to our present-day natural resources.

A Word About Behavioral Objectives

The goals of this module are defined through the use of behavioral objectives. The behavioral objectives establish a predetermined goal toward which learning is to be directed and by which attainment may be measured. This unit is intended to develop student changes in both the cognitive (knowledge) and the affective (attitude) domains. The behavioral objectives for this unit contain these basic parts:

1) The concept, or skill being evaluated.
2) The method by which the evaluation will occur (multiple-choice).
3) The expected criterion (percent of students who should correctly respond).
4) The Bloom's taxonomy level at which the concept will be tested.
5) The audience (participating students).
6) The expected behavior (selecting the best answer).

The present trend in education is toward stricter educational accountability. Behavioral objectives help define some of the desired outcomes for which education can be accountable.

Student learning is not all at the same level. For example, direct recall of a fact requires fewer mental manipulations than applying a concept to a new situation. One system for indicating the level of difficulty of a desired response is through the use of Bloom's taxonomy. The higher the Bloom's number assigned to an objective, the higher the level of desired competence with a particular concept. Following are descriptions of Bloom's levels assigned to each objective.

Cognitive Objectives

Knowledge Level	Intellectual Level (Cognitive)
1.12 Knowledge of Specific Facts	2.10 Translation
1.21 Knowledge of Convention	2.20 Interpretation
1.22 Knowledge of Trends and Sequences	2.30 Extrapolation
1.23 Knowledge of Classifications and Categories	3.00 Application
1.24 Knowledge of Criteria	4.10 Analysis of Elements
1.25 Knowledge of Methodology	4.20 Analysis of Relationships
1.30 Knowledge of Universals and Abstractions in a field	
1.31 Knowledge of Principles and Generalizations	
1.32 Knowledge of Theories and Structures	

Affective Objectives

1.0 Receiving Level
- 1.1 Awareness
- 1.2 Willingness to Receive
- 1.3 Controlled or Selected Attention

2.0 Responding Level
- 2.1 Acquiescence in Responding
- 2.2 Willingness to Respond
- 2.3 Satisfaction in Response

3.0 Valuing Level
- 3.1 Acceptance of Value
- 3.2 Preference for a Value
- 3.3 Commitment

4.0 Organization Level
- 4.1 Conceptualization of a Value
- 4.2 Organization of a Value System

Affective Objectives
(Continued)

The following behavioral objectives are intended to give teachers direction during the teaching of this unit. The behavioral objectives define only key concepts basic to the entire unit. They do not define all the learning experiences that will occur. The objectives will be revised as more student data becomes available. This data will provide the necessary information to calculate realistic criterion levels.

Please teach with the objectives, not the test questions, in mind. For the knowledge level objectives, students are expected to know specific things. However, for the intellectual level objectives, students are expected to take knowledge, apply it to an unfamiliar situation, and determine the best answer. Teaching the test question turns a level 2, 3, or 4 test question into a level 1, or knowledge level question.

Behavioral Objective Number	Test Question Number	Concept Tested	Bloom's Taxonomy Question Level	Pre - Post Growth Criterion	Activities Developing Objectives
1		Attitude questions are answered completely and truthfully (as measured by a and b below). a) Ninety percent of all students will respond to each opinion question. b) No more than 10 percent of the students will use patterned responses to unit evaluation questions.	2.2a		all
2	45	Environmental Education Project Modules are worth studying. *Posttest question only.	3.2a	70%	all
3	29	All schools should teach more about the ways the environment affects people and people affect the environment.	3.2a	10%	all
4	14	Select the areas of Kansas with the oldest and youngest rock layers near the surface.	1.22c	40%	B,C,H
5	15	Select the area of Kansas most likely to offer dinosaur fossils in rock layers near the surface.	1.22c	20%	B,H
6	19	Select the areas of Kansas most likely to contain coal in rock layers near the surface.	1.22c	20%	B,E,F,G,H
7	20	Indicate that fewer than one out of every 1000 animals which die will become a fossil.	1.30c	20%	B,E,H
8	21	Given four sketches of rock layers depicting anticlines, synclines, flat layers, and eroded anticlines, select the sketch of the area most likely to yield large quantities of oil.	2.20c	20%	C,H
9	22	Select tha area of Kansas with the greatest contrasts in physiography.	1.22c	20%	C,H
10	18	Select the most probable effect of mountain building on the surrounding land.	1.31c	20%	C,H
11	7	Indicate that more material is now being lost through erosion than is gained through deposition in Kansas.	1.22c	20%	D,G,H

Behavioral Objective Number	Test Question Number	Concept Tested	Bloom's Taxonomy Question Level	Pre - Post Growth Criterion	Activities Developing Objectives
12	5	Indicate that rocks (other than glacial) less than 250 million years old have eroded from Shawnee county.	1.12c	20%	D,F,H
13	6	Identify the origin of the red quartzite boulders found in Topeka.	1.12c	30%	D,H
14	17	Indicate that soil was the most valuable material deposited by the Kansas glacier.	1.24c	20%	D,H
15	11	Match the word "crinoid" with a picture of its plates.	1.12c	40%	E,H
16	14	Match a sketch of an ectoproct with a description of its food gathering mechanism.	1.12c	20%	E,H
17	23	Select the picture of a brachiopod from a set of four sketches.	1.12c	30%	E,H
18	4	Select the type of habitat responsible for depositing the material in limestone rocks.	1.12c	30%	F,H
19	16	Select the habitat responsible for depositing the material in shale rocks.	1.12c	25%	F,H
20	8	Given a cross-sectional sketch of a cliff, identify a limestone layer.	1.21c	40%	F,H
21	9	Given the above sketch, identify a shale layer.	1.21c	40%	F,H
22	24	Given a set of four cross-sections of rock layers which can be correlated, select the oldest and youngest layers of rock in the set.	2.30c	20%	F,H
23	10	Given a cross-sectional sketch of a cliff, students shall be able to select the bed of rocks best suited for building material.	1.21c	20%	G,H

Behavioral Objective Number	Test Question Number	Concept Tested	Bloom's Taxonomy Question Level	Pre - Post Growth Criterion	Activities Developing Objectives
24 & 25	25, 26	Given a set of four descriptions of the upper 10 feet of soil and rock, students shall be able to pick the condition most likely to cause two specific problems with home construction.	1.24c	20%	G,H
26	13	Given a sketch of rock layers on one side of a slump, select the best explanation of the cause.	2.10c	15%	H
27- 29	1-3	Identify labled specimens of limestone, shale, and echinoid fossils.	1.12c	30%	H

Module 2 CLASS PERFORMANCE SUMMARY SHEET

The following pages indicate how your class(es) responded to the pre and post-module tests. The following code is used throughout the test.

A - Percentage of students responding correctly on the pre-module test.

B - Percentage of students responding correctly on the post-module test.

C - Percent growth expected between pre and post-module tests.

D - Phi score for the test item. This score shows the quality of the test questions. Phi scores below 25 indicate either a poor test item or a topic that was not taught well in the unit. Phi scores above 40 indicate a very good test item which was well taught.

The opinion questions have two scores listed for each test result. "+" scores indicate the percentage of students agreeing with the statement and "-" scores indicate those disagreeing. The students with no opinion make up the remaining and unreported percentage.

The correct answers are circled.

1. - 3. Examine the labeled specimens and identify them using the names in the lists below.

A ____ B ____

1) (A) Limestone; B) Hematite; C) Shale; D) Quartzite

C 30% C ____

A ____ B ____

2) A) Brachiopod; (B) Echinoid; C) Crinoid; D) Pelecypod

C 30% C ____

A ____ B ____

3) A) Sandstone; B) Limestone; C) Basalt; (D) Shale

C 30% C ____

4. Which situation probably led to the formation of the limestone in Calhoun Bluffs?

A ____ B ____

(A) A deep sea covered the area for many years.
B) A shallow swamp with rich plant life covered the area.
C) Running rivers laid down limestone from the Rockies.

C 30% D ____

D) A deep lake evaporated over this area, leaving lime deposits.

5. Which statement is true about rock that is 50 - 100 million years old in this area of Kansas?

A ____ B ____

A) It is covered by the Pennsylvanian rock, so we cannot see it.
B) It contains the limestone seen in Calhoun Bluffs.
(C) It was eroded away and no longer exists in this part of Kansas.

C 20% D ____

D) It was brought down by the Kansas glacier.

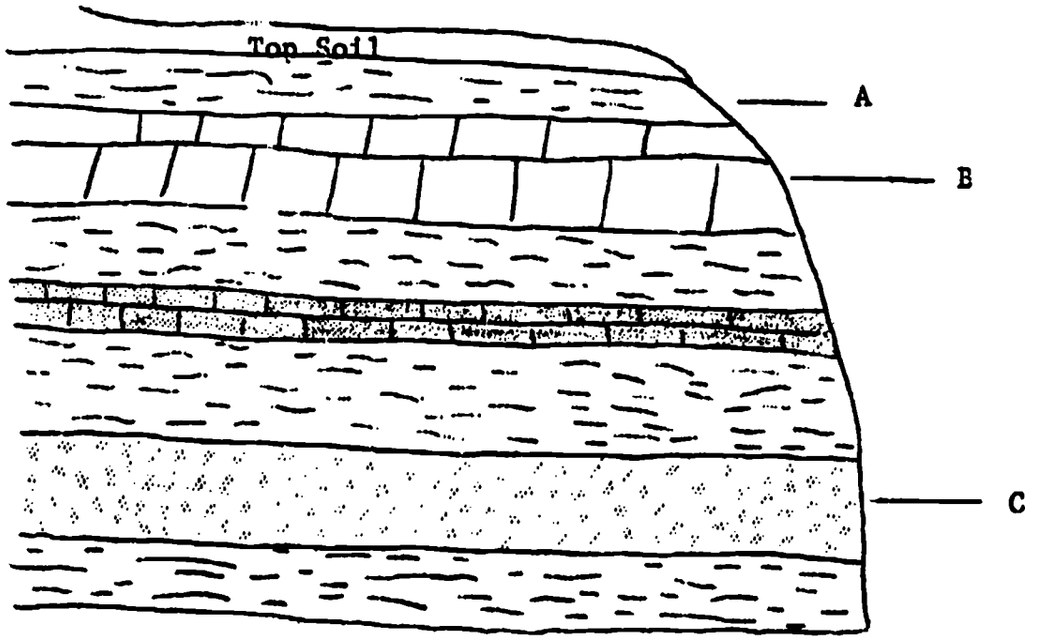
6. Red quartzite boulders are:

A) Metamorphic limestone.
B) Brought to Kansas by glaciers.
C) Created by volcanic activity near Manhattan.
D) Brought to Shawnee County by streams from Western Kansas.

7. Which of the statements below is correct?

A) Rock is now being formed faster than it is eroded in Kansas.
B) Rock is now being formed at the same rate that it is eroding in Kansas.
C) Rock is now being formed slower than it is eroding in Kansas.
D) Geologists lack the data needed to answer this question.

Examine the sketch below; then answer questions 8 - 10. Each letter could be used more than once.



8. Which layer of rock is limestone?

A B C

9. Which layer is shale?

A B C

10. Which layer would make the best building material?

A B C

11. Which of the following animals left this fossil?

A) Brachiopods (B) Crinoids C) Ectoprocts D) Corals

A B

40%
C D

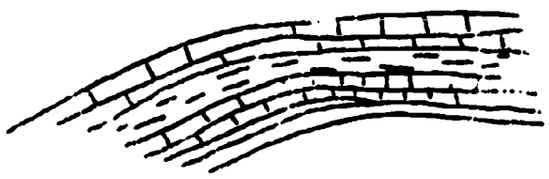
12. Select the correct statement about rocks near the surface of different parts of Kansas.

(A) Eastern Kansas rocks are older than Western Kansas rocks.
B) Western Kansas rocks are older than Eastern Kansas rocks.
C) Rocks in all parts of the state are about the same age.
D) Rocks in the southwest corner of Kansas are the oldest rocks.

A B

30%
C D

13. Examine the sketch below, and choose the best explanation for the difference between its right and left sides.



A) Erosion has lowered the rocks on the left.
(B) Erosion has cut layers from below the rocks on the left.
C) Rocks were deposited into an old river valley on the left.
D) The delta's edge was to the right, so rocks were built higher.

A B

15%
C D

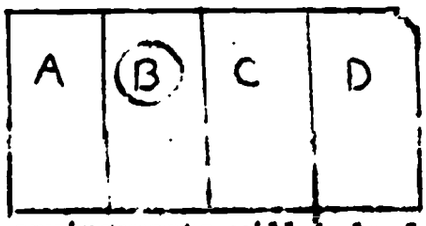
14. Which of the following animals are very tiny and collect food with waving tentacles? Its colonies leave fossils with this pattern:

A) Brachiopods (B) Ectoprocts C) Fusulinids D) Gastropods

A B

20%
C D

15. On the Kansas map below, what area includes the counties where you would be most likely to find dinosaur fossils?



A B

20%
C D

16. Which of these environments will help form shale?

A) Deep ocean water.
B) Shallow ocean water.
(C) Mud flats in deltas.
D) River bottoms and shallow lakes.

A B

25%
C D

17. What material left by glaciers in Shawnee County provides the greatest income for citizens of the county?

A) Gem stones
B) Soil
C) Quartzite
D) Sand and gravel

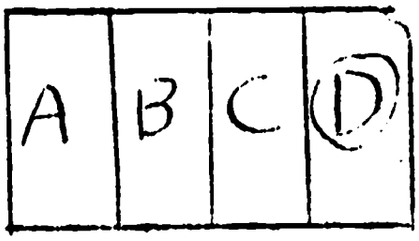
A B C D 20%

18. If half of Kansas was pushed up into the air about 4,000 feet, what would probably happen to Missouri and Oklahoma?

A) They would have volcanoes erupt.
B) They would be lifted along with Kansas.
C) They would soon receive rocks and sand from erosion of Kansas.
D) They would experience no particular change.

A B C D 20%

19. Which of the areas marked on the Kansas map below are most likely to contain coal layers near the surface?



A B C D 20%

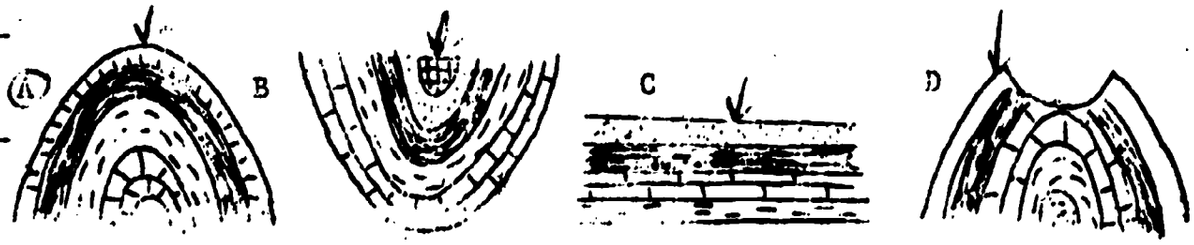
20. If 1,000 animals died today in Kansas, how many would probably become fossils?

A) 100 or more
B) 10-99
C) 1-9
D) Probably none of the animals would become fossils.

A B C D 20%

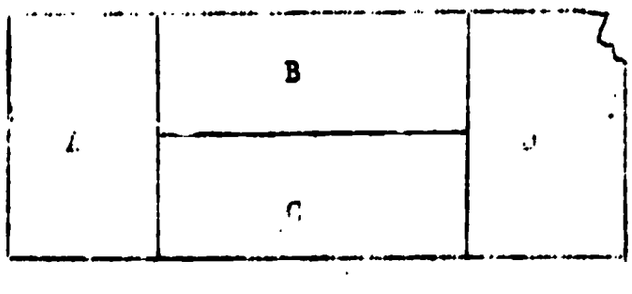
21. If the dark layer of rocks contained oil, which one of the rock arrangements would yield the most oil at the spot indicated by the arrows?

A B C D 20%



22. On the map below, select the area of Kansas with the greatest contrasts in hills, valleys, and scenery.

A B C D 20%

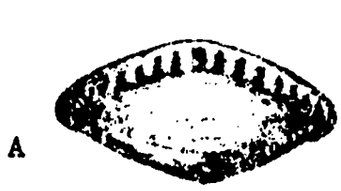


23. Which of the pictures below is of a brachiopod?

A B

30%

C D

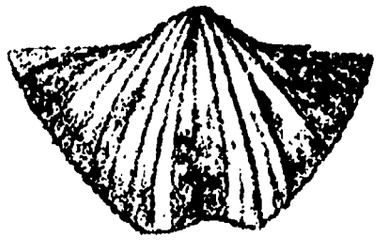


A

B

C

D



24. Examine the four cross sections below, and select the oldest and youngest rock layers. Rock layers of the same type are numbered the same.

A) 1 = youngest, 12= oldest (B) 13 = youngest, 6 = oldest C) 9 = youngest, 10 = oldest D) 3 = youngest, 2 = oldest

A B

20%

C D

1	13	9	3
7	8	2	5
9	1	3	14
2	7	5	12
10	9	14	6
	2	12	

Use the four descriptions below to answer questions 25 and 26.

A. A thick layer (30 feet +) of silt and glacial debris covers limestone rock.
B. A thin broken layer of sandstone covers a thick (30 + feet) layer of shale.
C. A thin layer of shale and soil covers a thick layer of limestone.
D. A thin layer of soil covers a thick layer of stream deposits.

25. Which of the conditions above will be certain to be very expensive for home building and laying sewage systems?

A B C D

20%

26. Which of the conditions above will require a reinforced basement and will not allow most septic systems to work well?

A B C D

PART B

Your answers to questions 27-46 will help us determine what you think of the module in general. Please use this key:

A = Yes (or I agree) B = I'm not sure C = No (or I disagree)

_____ +B-	27.	I think we had to go through this module too fast.	A B C
_____ +B-	28.	I think our class discussions were interesting and informative.	A B C
_____ +B-	29.	Schools should teach more about the ways the environment affects our lives.	A B C
_____ +B-	30.	My teacher helped answer most of my questions about ideas presented in this module.	A B C
_____ +B-	31.	I think we used the self-test questions in a way that helped me learn and think.	A B C
_____ +B-	32.	We discussed the films in a way that helped each of us learn and think.	A B C
_____ +B-	33.	I think my teacher enjoyed teaching this module.	A B C
_____ +B-	34.	I think most other students enjoyed studying this module.	A B C
_____ +B-	35.	Most of the necessary papers and supplies were ready when we needed them.	A B C
_____ +B-	36.	I think that most of the questions asked by this test were fair.	A B C
_____ +B-	37.	I think the papers in this module contain useful and interesting information.	A B C
_____ +B-	38.	I think the papers in the module could be easily read.	A B C
_____ +B-	39.	I think the ideas covered in this module fit together pretty well.	A B C
_____ +B-	40.	The films used in the module were interesting and useful.	A B C
_____ +B-	41.	I enjoyed taking the trip, and I learned a lot.	A B C
_____ +B-	42.	The trip leaders did a good job helping me learn on the trip.	A B C
_____ +B-	43.	I discussed some of the things in this module with my family or friends.	A B C
_____ +B-	44.	I think the activities and exercises in this module were interesting and useful.	A B C
_____ +B-	45.	Overall, I think this module was well worth the time we spent studying it in class.	A B C
_____ +B-	46.	I would like to study other modules developed by the Environmental Education Project.	A B C

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project

INTRODUCTION

The Environmental Education Project was created by the Topeka School System to help you learn about your environment. The project develops and tests materials for classroom and field trip activities. This module is about geology. You will study how the rocks beneath you were formed, and how their presence affects your life today.

The module discusses four main questions:

1) What forces have shaped the hills and formed the soils in Shawnee County?
2) What are the fossils found near Topeka, and what environment was needed to produce them?
3) How do the rocks and fossils of Kansas vary across the state?
4) How does geology affect the life of a city dweller?

Following your study of this module, your class will investigate the rocks found at Calhoun Bluffs, a large cliff northeast of Topeka on Highway 24.

The Environmental Education Project will use test results to determine what you learned from the module and what you think about different parts of it. You will be given tests over the module before and after you study it. The tests will be used to determine what changes should be made in the material. Whether or not the teacher grades you using these test results is a decision to be made by your teacher. Test questions will be drawn from student self-test questions with each paper and the field trip.

All of your answers to the factual test questions will be reported to your teacher for use in grading. The test will also contain a set of questions about your opinions. Your answers to these questions will be used by the Environmental Education staff to improve the material you are studying.

Green pages in the teacher's material usually will contain three sections:

1) 'Topics and Concepts' - lists the ideas from the student papers and exercises that will be on the final test. The numbers of the topics correspond with the behavioral objectives listed in the front portion of this module.

2) 'Teacher Suggestions' - provides background material and suggestions for presenting the paper or exercise.

3) 'Answers to Student Self-Test Questions' - provides answers and follow-up material to help in a discussion and review of the self-test.

This introductory paper is concerned with the following three attitudes. They will be nurtured throughout the next two weeks as the students work with this module.

TOPICS AND CONCEPTS TESTED

1) Students should read each opinion question on the final test and try to respond truthfully.

2) Upon completion of this module, students should indicate a desire to study other modules developed by the Environmental Education Project.

3) Upon completion of this module, students should indicate a desire to study more material about man's relationship to his environment.

TEACHER SUGGESTIONS

Please bring out three points during the introduction:

1) This module is about geology, which plays a very large, but often unseen, role in everyone's life.

2) The project is very interested in student and teacher opinions, criticisms, and compliments. We get these comments during the field trip, from teachers, verbal and written comments, and from opinion questions on the student test. Please encourage students to react to the material being presented. Pass their reactions and yours on to us.

3) You should make it clear if students will be graded using the factual part of the posttest. The tests are fair, and are strictly based on the behavioral objectives included in this module. If the students understand each paper's student self-test questions and the field trip material, they should do very well on the posttest.

Ancient Life

Geologists divide history into large chunks of time called periods. Several periods are then grouped together to form eras. The film Earth Science: Parade of Ancient Life reviews how animal and plant life has changed during the three most recent eras. As you watch the film, try to identify kinds of animal and plant fossils you would expect to find in different areas of Kansas.

In Kansas, the rocks near the state's surface represent only six different periods in three eras. Rocks formed during other periods either eroded years ago or are found deep beneath the state's surface. The map below shows the periods when the surface layers of rocks were formed. The chart below the map shows when each period was in existence.

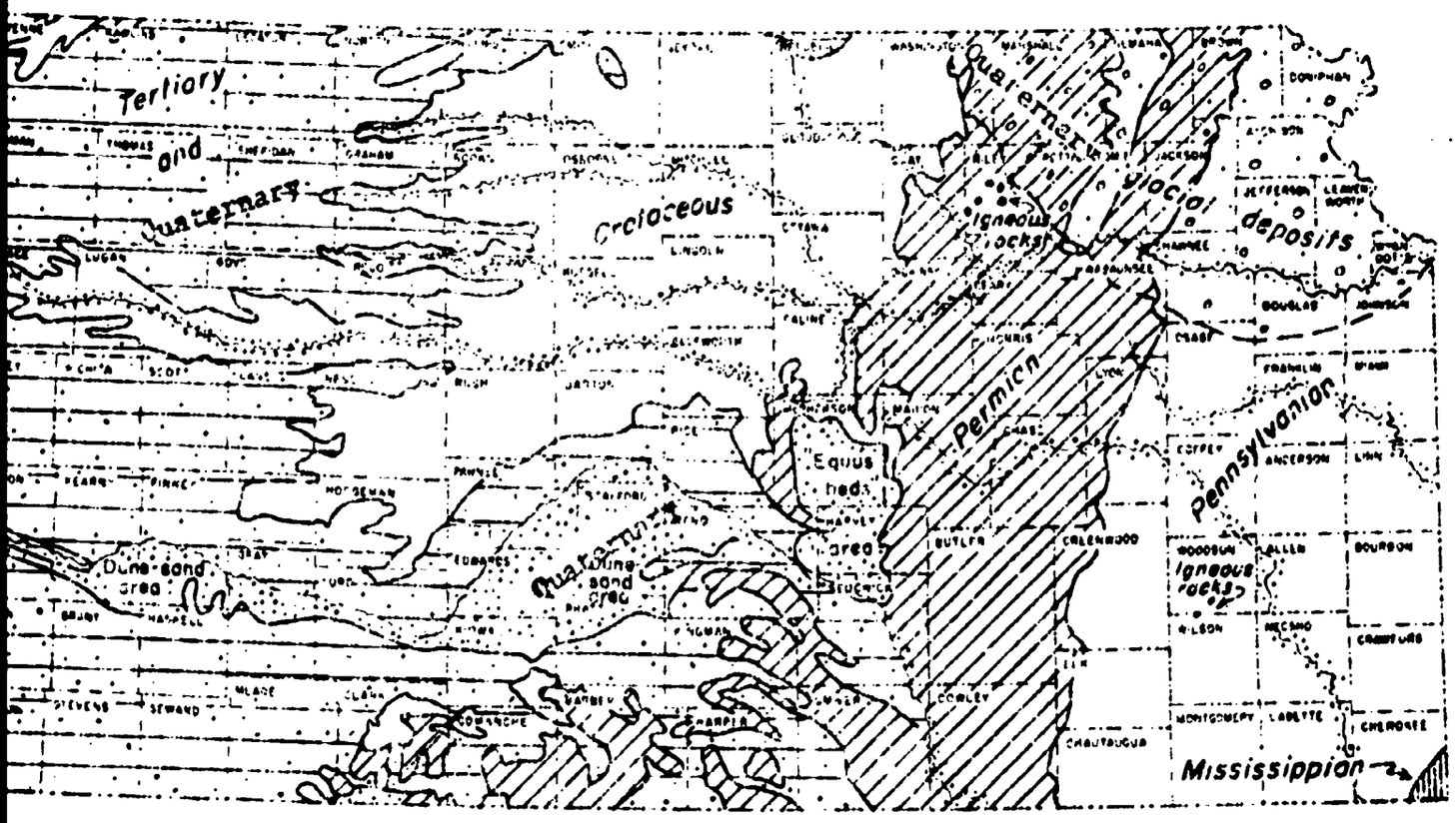


Figure 1. Surface Rock Layers of Kansas (note: thin quaternary layers of soil and river deposits are not shown on this map.)

Era	Period	Approximate Time of Deposition
Cenozoic	Quaternary	Now - 1 million years
	Tertiary	1 - 70 million years
Mesozoic	Cretaceous	70-135 million years
	Permian	225-270 million years
Paleozoic	Pennsylvanian	270-330 million years
	Mississippian	330-350 million years

Table 1. Ages of Rock Surface Layers of Kansas

View the film, and answer the questions below.

Student Self Test

1) Which county in Kansas has the oldest surface rocks?

2) Shawnee County has a thin layer of Quaternary glacial deposits which lie over thick rock layers of another period. According to the map, how old are those thick rock layers?

3) "Equus" means "horse." Where in Kansas would you expect to find horse fossils? These fossils were formed during what period?

4) Describe the plants and animals that were alive when the Pennsylvanian rocks were being deposited.

5) Where would you expect to find coal in Kansas?

6) Describe the plants and animals that were alive when the Cretaceous rocks were being deposited.

7) Describe the plants and animals that were alive when the Tertiary and Quaternary rocks were being deposited.

8) If 1000 animals died in Kansas this year, how many would you expect to become fossils?

Topics and Concepts

4. Given a map of Kansas divided into five sections, students shall be able to select the sections offering the oldest and youngest surface layers of rock.

5. Given the map described above, students shall be able to select the section most likely to contain dinosaur fossils in the surface layers of rock.

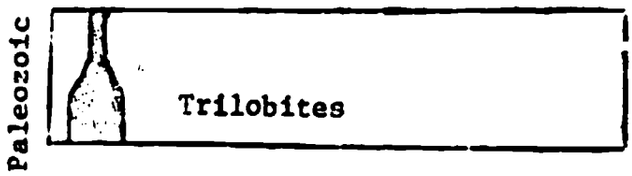
6. Given the map described above, students shall be able to select the sections most likely to contain coal.

7. Students shall indicate that less than one out of every 1000 animals which die becomes a fossil.

Teacher Suggestions

Before showing the film, have students read Paper B and discuss the ages and locations of the various rock layers in Kansas. Student Self Test questions 1, 2, and 3 could be answered at this time. Should students ask where the Jurassic and Triassic (135-270 million years ago) rocks have gone, point out that they are thin layers of sandstone and shale which have largely eroded and seldom make an appearance between the Permian and Cretaceous deposits.

Begin showing the film Earth Science: Parade of Ancient Life, and allow it to run until the following chart for Trilobites first appears. Stop the film and ask the review questions below.



The film mentions that most fossils are found in sedimentary rocks. Why are fossils located in them?

Answer. Sedimentary rocks are formed from sand, mud, or dead bodies of millions of small animals and plants. Fossils may be formed when an organism, or parts of an organism are buried in the sediments.

Turn on the projector, but use the "still" knob to hold the chart of the Trilobite population on the screen. Explain that the number of animals is based on estimates made from the number of fossils discovered in rocks of the various periods.

Ask the question: "Would you find more Trilobites in the early or late Paleozoic rocks?"

Answer: Early Paleozoic

Ask the question: Would you expect to find large numbers of Trilobites in upper Pennsylvanian rock layers?

Answer: No

Before proceeding with the show, point out that the rocks around Topeka were deposited during the Pennsylvanian Period. The fossils which will be shown for the rest of the Paleozoic Era can be found in limestone around Topeka.

NOTE: Running the film in reverse momentarily before continuing through the film will enable students to pick up the thrust of the film when it was stopped.

Stop the film when it begins to introduce the Mesozoic Era using the time line beginning 240 years ago and ending 70 million years ago.

Ask the students these questions:

1. How did the kinds of animals with backbones change during the Paleozoic Era?

Answer: Fish developed. Some of these fish developed lungs and primitive legs. From these fish, amphibians developed. At the end of the era, many fish, lung fish, and amphibians were living.

2. How did plant life change during this era?

Answer: Primitive algae developed into more complex seaweeds. Some of this seaweed developed the ability to live along the water's edge where they were alternately covered by water and air. Some of these plants developed into the dense evergreen swamps which made most of the coal and oil we use today. In Kansas, coal seams are common only in the Pennsylvanian rocks which were formed by a large ocean which alternately retreated to expose vast mud flats and swamps, then advanced to bury the swamps with deposits which eventually became limestone.

3. How did plants of the Paleozoic Era influence the lives we lead today?

Answer: Coal, oil, and natural gas are all created from dead plant bodies from the Paleozoic Era.

Before proceeding, have students answer Student Self Test questions 4 and 5.

Stop the film after reaching the introduction to the Cenozoic Era. Ask these questions at this point:

1. How did backboned animals change during the Mesozoic Era?

Answer. Some amphibians developed into reptiles. Some reptiles developed into primitive birds and mammals. At the conclusion of this era, fish, amphibians, reptiles, mammals, and birds were all common.

2. What types of reptiles lived during the Mesozoic Era?

Answer: Dinosaurs lived on land and in the water. Some reptiles could fly. In addition, reptiles like those living today lived at this time. These included snakes, turtles, and crocodiles.

3. What changes occurred in plants during this era?

Answer: The evergreens were largely replaced by flowering plants by the end of the Mesozoic.

Before proceeding, have students answer questions 6 and 7.

Finish the film, then use this question to review the Cenozoic Era.

1. What changes occurred in backboned animals during the Cenozoic Era?

Answer: Most reptiles disappeared, modern birds and mammals appeared, and man appeared very late in the era. Although the film did not mention this, most modern bony fish first appeared during the Cenozoic.

Answers - Student Self Test Questions

Q-1. Which county in Kansas has the oldest surface rocks?

A. Cherokee (S. E. corner)

Q-2. Shawnee County has a thin layer of Quaternary glacial deposit lying over thick rock layers of another period. According to the map, how old are those thick rock layers?

A. The layers are Pennsylvanian rocks, 270-330 million years old.

Q-3. "Equus" means "horse." Where in Kansas would you expect to find horse fossils? These fossils were formed during what period?

A. The "Equus beds" are in central Kansas in McPherson and Harvey Counties. The dotted pattern used to indicate the area is that used for the Quaternary sand dune area, so the fossils are less than one million years old.

Q-4. Describe the plants and animals that were alive when the Pennsylvanian rocks were being deposited.

A. In the oceans, many species of fish, coral, brachiopods, protozoa, and a wide variety of algae were present. Dense evergreen forests with many species of insects, slugs, and other primitive animals existed on land.

Q-5. Where would you expect to find coal in Kansas?

A. You would predict coal in the Mississippian, Pennsylvanian, and Permian rocks since much of the world's coal was formed during the Paleozoic Era. These rocks occupy the upper layers of the eastern third of Kansas.

In fact, only the Pennsylvanian layers have large deposits of coal. The Mississippian Period left mostly a cherty limestone with some beds of zinc and lead and salt. During the Permian Period, a portion of the ocean which covered Kansas was cut off and left behind thick layers of evaporites, limestone, and red sandstone, but very little coal.

Q-6. Describe the plants and animals that were alive when the Cretaceous rocks were being deposited.

Q-6. Describe the plants and animals that were alive when the Cretaceous rocks were being deposited.

A. During the Cretaceous Period, dinosaurs became the dominant land animals, but primitive birds and mammals were appearing and beginning to provide competition near the conclusion of the period. Evergreens were being replaced by flowering deciduous plants, and a wide variety of wild life communities were taking form.

Q-7. Where in Kansas would you expect to find dinosaur fossils?

A. Dinosaur fossils would be expected in the north central counties and along the Smoky Hill River as it extends west to Wallace County.

Q-8. Describe the plants and animals that were alive when the Tertiary and Quaternary rocks were being deposited.

A. Mammals, birds, and flowering plants evolved at a rapid rate during this period. The first of the grassland planes appeared and were filled with horses, camels, elephants, bison, and tigers. In the Quaternary Period, two ice sheets advanced into the upper corner of the state, and about 20,000 years ago, man arrived in the state.

Q-9. If 1,000 animals died in Kansas this year, how many would you expect to become fossils?

A. None. Most animals are eaten or decayed long before layers of sand or other sediments can exclude enough oxygen to halt decomposition. Only the very rare animal who was buried by mudslide, thick layers of flood mud, or volcanic ash would have the remote chance of becoming a fossil in later years. Scientists estimate that the average animal (worm, insect, horse, or whatever) has much less than a 1 in 1,000 chance of becoming a fossil.

Geology of Kansas

Most people are familiar with the sedimentary rocks lying near the surface in Kansas, for these are seen beside roads, in stream channels, and at construction sites. However, the rock layers dip downward as you go west in Kansas. Thus, the rocks at the surface in Shawnee County are over 1,000 feet beneath the surface in Saline County, just 100 miles to the west.

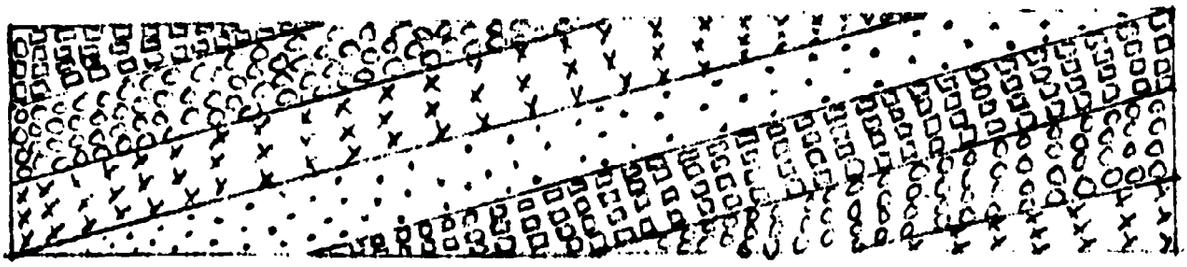


Figure 1. Sedimentary Rocks Dip Down to the West in Kansas.

In addition to dipping to the west, two other major forces influenced the positions of the rock layers in Kansas: A) Rock layers have been distorted as anticlines have pushed layers upward to be eroded and basins have sunk to be filled with sediments. B) The Rocky Mountains began to rise about 75 million years ago. As they pushed up, rivers carrying rocks, gravel, and sand from the eroding mountains washed over western Kansas and left behind hundreds of feet of deposits. These deposits left the great Plains. In addition, all of Kansas eroded, with the eastern half eroding the most rapidly and losing thousands of feet of rock layers.

If one had a giant knife and could cut across the middle of the state from the west to the east, the rock layers would have the shape shown below.

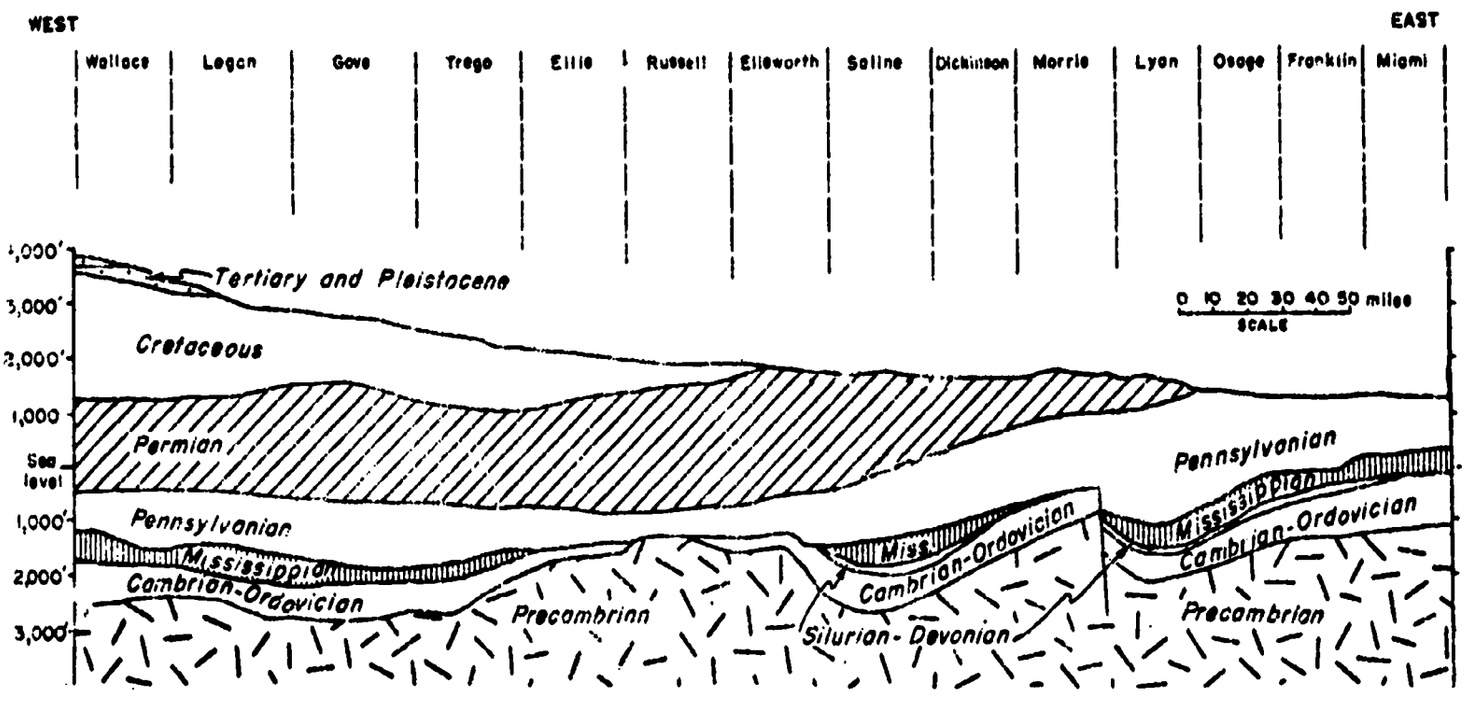


Figure 2. Cross Section of Kansas Rocks.

One thing should be noted--the cross section above is only seven thousand feet thick, but is over two million feet long. The rock layers are really quite thin when compared with the total width of the state.

The shape and position of these underground rock layers strongly influences where oil will be found. For instance, the sharp bump in the Precambrian rock in Morris County marks the Nemaha Anticline. This anticline extends across Kansas from Nebraska to Oklahoma. It pushed upward during the Pennsylvanian Period, causing a sharp bend in the Mississippian rocks which contained large quantities of oil. Since oil moves upward through porous rock layers, it migrated to the top of the anticline. There, much of the oil bearing rock was eroded before the anticline was covered by Pennsylvanian deposits. Many oil wells in Kansas are drilled over the Nemaha Anticline seeking to remove the oil remaining in the Mississippian rocks. Some wells are successful, others find no oil because the oil bearing rocks eroded millions of years ago.

The tilt of the rock layers and the kinds of rocks near the surface also influence the appearance of the Kansas landscape. Geologists classify Kansas into several physiographic provinces, or areas of similar hills, valleys, and exposed rock layers.

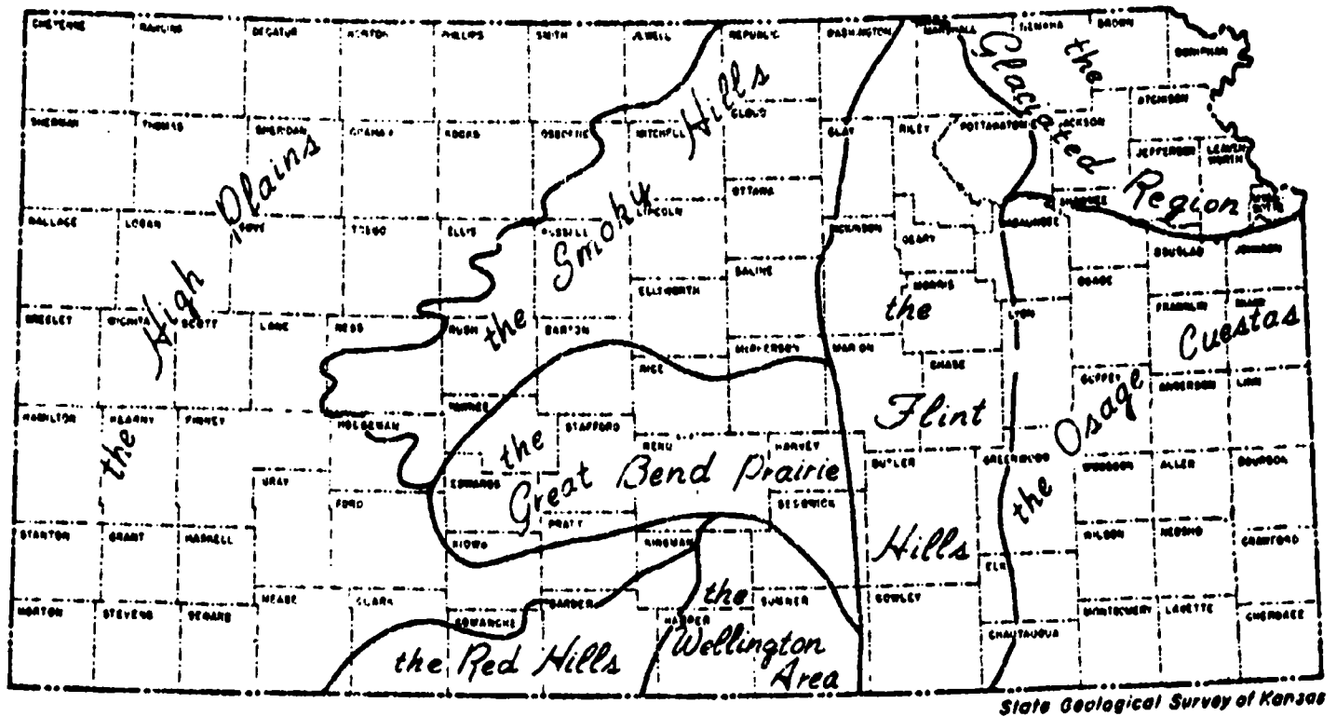


Figure 3. Physiographic Provinces of Kansas.

The Osage Cuestus in Southeastern Kansas contains a series of east facing cliffs formed when soft shales of the Pennsylvanian Period erode beneath protective layers of hard limestone.

Figure 4. Osage Cuesta Cross Section.

The Glaciated Region of Northeastern Kansas contains rolling hills formed by erosion of thick layers of soil, pebbles, and boulders left behind by glaciers which retreated only 20,000 years ago.

The Flint Hills of east central Kansas contain steep-sided hills covered with flat caps of cherty limestone.

The Red Hills are one of the most beautiful areas of Kansas, with very steep sided buttes and mesas towering above ravines. All of these features are cut from red sandstones and shales formed during the Permian Period.

The Wellington Area is similar to the Red Hills, but the red shale is softer and the steep buttes are replaced by medium sized hills.

The Great Bend Prairie is formed from Quaternary sands deposited by the Arkansas River, and later blown about by winds. These winds created huge sand dunes. The hills have not blown much since the dust bowl of the 1930's, so grass and small trees now cover the rolling sand dunes.

The Smoky Hills feature flat topped mesas and ridges with caps of rusty-brown sandstone and low hills formed of the shale and chalk beds deposited during the Cretaceous Period.

The High Plains are the very flat plains formed of sands and gravels carried from the Rocky Mountains during the Tertiary Period. The flat plains are cut into broad river valleys and narrow canyons and draws by the infrequent rains of the area.

Thus, Kansas contains a variety of landscapes carved from rocks millions of years old. By knowing ages of the rocks, the slope of the surface rocks, and the recent geologic history of the area, geologists can predict the fossils, slopes of hills, and minerals most likely to be found under each of the counties in Kansas.

Student Self Test

1) Name one county in Kansas which would need a tunnel over two thousand feet deep to find a fossil from the Permian Period.

2) Name one county in Kansas which could not obtain a Permian fossil no matter how far they tunneled down. List two possible reasons why no Permian fossils would be found in this county.

3) Why do geologists seek to locate anticlines, not basins, when they are drilling for oil?

4) Would you expect to find large fields of very productive corn in Barber County? Why or why not?

5) In which of the physiographic provinces of Kansas would the hills change shape the most rapidly during a severe drought? Why?

6) In which of the physiographic provinces of Kansas would builders have the most trouble predicting the kinds of rocks they would find when digging trenches for foundations and sewer lines?

7) Which pair of physiographic provinces in Kansas has been greatly affected by occurrances in surrounding areas?

Behavioral Objective Number

4. Given a map of Kansas divided into five sections, students shall be able to select the sections offering the oldest and youngest surface layers of rocks.

8. Given four sketches of rock layers depicting anticlines, synclines, flat layers, and eroded anticlines, the sketch of an area most likely to yield large quantities of oil.

9. Select the area of Kansas with the greatest contrasts in physiography.

10. Students shall be able to select one effect of mountain building on the surrounding lands.

Teacher Suggestions

In presenting this paper, students may ask questions about the Silurian, Devonian, Cambrian, Ordovician, and Precambrian rocks. These layers were not discussed in the previous paper since they do not appear near the surface in Kansas. All but the Precambrian layers consist primarily of limestone, with some layers of shale, sandstone, and dolomite. All contain some oil, with gas and water found in the Ordovician rock.

The Precambrian layers contain a mixture of igneous and metamorphic rocks.

Answers - Student Self Test Questions

Q-1. Name one county in Kansas which would need a tunnel over two thousand feet deep to find a fossil from the Permian Period.

A. Wallace County and most other counties in the western tier would have Permian rocks well over 2,000 feet beneath the surface.

Q-2. Name one county in Kansas which could not obtain a Permian fossil no matter how far they tunneled down. List two possible reasons why no Permian fossils would be found in this county.

A. Franklin, Miami, and most other counties in the eastern two tiers would not contain Permian fossils because either 1) the Permian rock has completely eroded or 2) the rock was never deposited.

Q-3. Why do geologists seek to locate anticlines, not basins, when they are drilling for oil?

A. Oil tends to migrate upward in rocks which allow its passage. In an anticline, the oil would move up until an impervious layer was reached. In a basin, the oil would be diffusely spread throughout the area. (The main reason for frequent disappointments in drilling over the Nemaha Anticline is that the impervious capping layers were penetrated and much of the oil probably drained into the seas of the Pennsylvanian Period as it migrated up the anticline.)

Q-4. Would you expect to find large fields of very productive corn in Barber County? Why or why not?

A. No. The Red Hills are in a dry area with extremely rugged terrain of buttes, mesas, and ravines. Lack of moisture (as indicated by the terrain) and a lack of areas for large fields of anything are indicated by the description of the Red Hills.

Q-5. In which of the physiographic provinces of Kansas would the hills change the most rapidly during a severe drought? Why?

A. The Great Bend Prairie, with its huge sand dunes now covered with thin layers of vegetation, is the province most susceptible to wind erosion. The drifts are much more likely to change shape than are the limestone or sandstone capped hills characterizing much of the state. The high plains, with their flat surfaces of water deposited soil, gravel, and sand are susceptible to severe wind erosion, but whole hills will seldom be created or destroyed.

Q-6. In which of the physiographic provinces of Kansas would builders have the most trouble predicting the kinds of rocks they would find when digging trenches for foundations and sewer lines?

A. The Glacial Region can give builders many suprises. Conglomerate layers of granite, quartzite, and chert cemented by water deposits may lie near the surface. Huge boulders of metamorphic and igneous rock may be buried under thin (or thick) layers of soil. Thick layers of loess (wind blown soil) may form the hills. All in all, planning major construction projects always involves a degree of risk in this region.

Q-7. Which pair of physiographic provinces in Kansas has been greatly affected by occurrances in surrounding areas?

A. The High Plains received very large amounts of debris from the Rocky Mountains as they eroded.
The Glaciated Region was affected by ice formed as far north as Canada.
The Great Bend Prairie was strongly affected by sand washing from the Rocky Mountains, over the Great Plains, and into the Arkansas River Valley.

Calhoun Bluffs---A General Description

You have studied the periods when sedimentary rocks were deposited in Kansas, the general outline of the rock layers underground, and the ways these rocks affect the appearance of Kansas. This paper will begin a discussion of a specific area in Kansas, Calhoun Bluffs.

A description of Calhoun Bluffs should begin with the present day surface that is easily seen to the north of the Kansas River and in a few instances a little south of the River. As you go to Perry Dam and Reservoir from Topeka, you pass through some of the most distinctive land and countryside of any in Kansas. Civilized human occupation of this land may perhaps go back only 130 years; but the history of this land began long before this. (See attached map, page 2.)

This land is, of course, as old as the earth in one way of looking at it. But in the form that you now observe it, in the form of these rocks, rolling uplands, and stream eroded valleys, its history started about 300 million years ago.

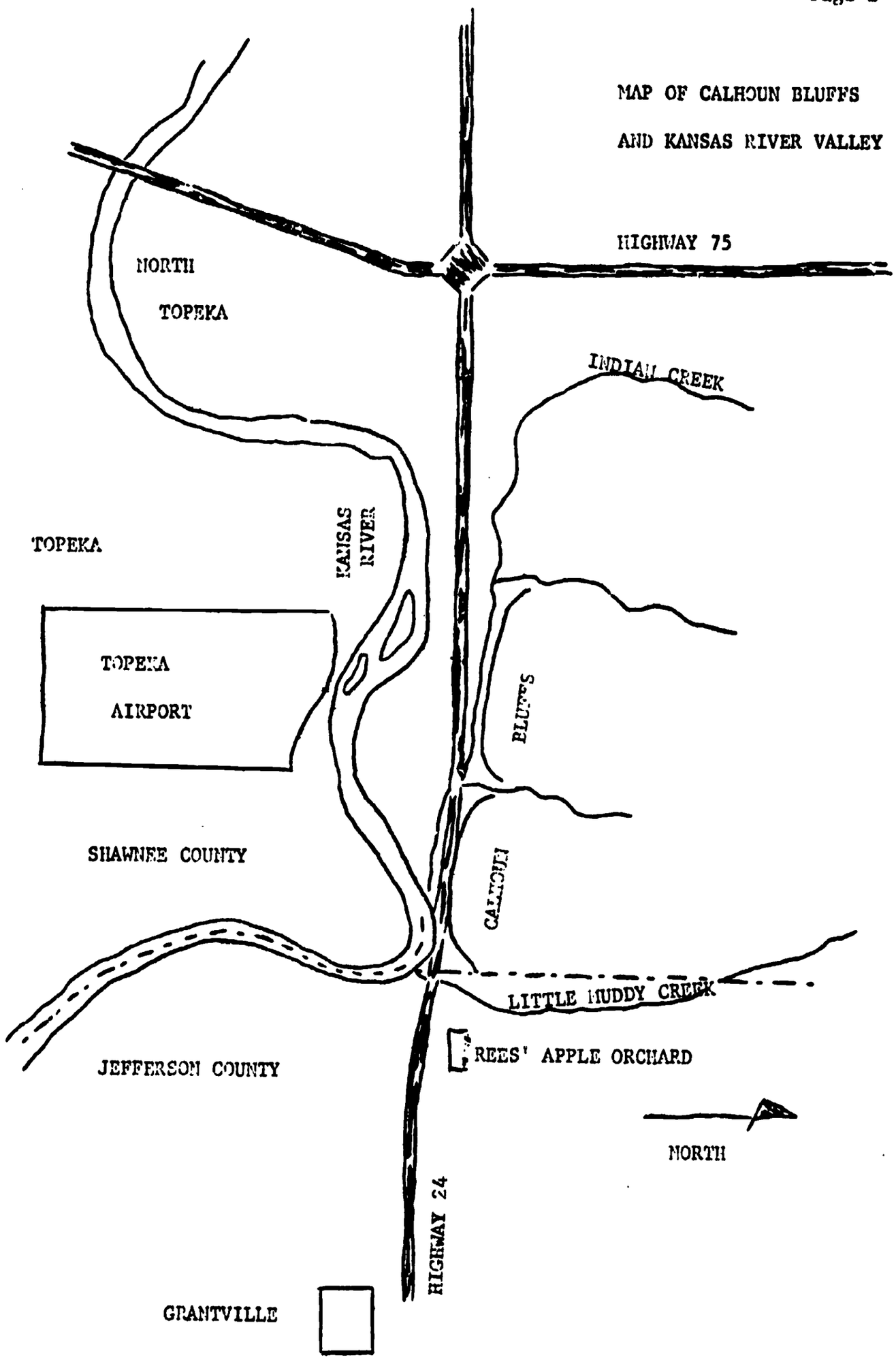
About this time (300 million years ago) is when these rocks were being deposited along the edge of a great inland ocean. These deposits built up limestone, shale, and sandstone. Any rocks deposited from about 275 million years ago until the past 1,000,000 years have been eroded away in this part of Kansas.

The name of the bluffs comes from the fact that they were in Calhoun County, Kansas, which was later changed to Jackson County. Calhoun County was named in honor of John C. Calhoun. Politicians in early day Kansas, fighting for Topeka to be the county seat as opposed to Tecumseh and other hopefuls, changed the northern boundary of Shawnee County from the Kansas River north to include North Topeka and land for several miles north, so that Topeka would be more centrally located. This was done in October of 1857. This move made the Calhoun Bluffs (which retained their name after Calhoun County was changed to Jackson County) a part of Shawnee County.

Much of the topsoil of northeastern Kansas was brought here during the last million years by glaciers from the north which twice invaded Kansas. The first glacier to cover any part of Kansas was the Nebraskan, which covered only a few extreme northeastern counties. The second, the Kansas glacier, covered more territory, extending as far south as the northern parts of Shawnee, Douglas, and Johnson Counties and as far west as Marshall and Pottawatomie County. Altogether, it touched or covered thirteen counties of northeastern Kansas.

This glacier created much of our valuable topsoil as it melted, dropped its load of rocks and soil, and retreated northward. The deposited material was left as it fell with large rocks right alongside small pebbles. It is called unconsolidated Kansas till. In this till are found rock sizes from boulders to clay, sand, pebbles, and gravel. Red Quartzite boulders are a prominent feature of the landscape and these are easily recognized.

This glacial till, since the retreat of the last glacier some ten or eleven thousand years ago has been weathered and eroded, giving the softly rounded undulating surface of the uplands and broad river valleys such as the Kansas River Valley upon which Topeka is situated. In the Calhoun Bluff area this topsoil is about three and one-half feet thick.



The area to the north of the Kansas River is excellent for collecting rock specimens of exotic types including gemstones of interest to the "rock hound" as well as specimens for the amateur geologist. Some of the more interesting types are Lake Superior agate, jaspers, brain agate, smoky quartz, rose quartz, and banded chert. Granites, geodes, iron ores, native copper, quartzite, boulder clays and other types may also be found. The origin of these materials is from Iowa and farther north, where the debris was scraped from their place of origin and transported in the glaciers to this area and deposited.

Sands and gravels from the Kansas till have been eroded from the surface and deposited in river valleys in sorted layers. The sands are of economic importance, and we have several sand companies on the Kansas River at Topeka. The clay of the glacier deposits north of Topeka are also of economic value in the ceramics industry. The very fertile soil of the Kansas River Valley is due in great part to the deposits first brought here by the glaciers and transported then by rivers and streams to the Kaw Valley.

The contours of the land where we live and the surface itself is due to the action of the past million years, glaciation, deposition, then erosion, weathering and redeposition.

Student Self Test

1. What happened to rocks in this area that are 100-200 million years old?

2. What has caused Topeka to have a wide variety of rocks in the surface layer of soil?

3. How did the glacier contribute to our economy?

4. Which type of rocks deposited by the glacier is most commonly seen in Topeka?

Behavioral
Objective
Number

11. Students shall indicate that in Kansas more material is now being lost through erosion than is gained through deposition.

12. Students shall indicate that rocks (other than glacial) deposited less than 300 million years ago have eroded from Shawnee County.

13. Students shall correctly identify the origin of the red quartzite boulders found in Topeka.

14. Students shall indicate that the soil was the most valuable material deposited by the Kansas glacier.

Teacher Suggestions

This paper is designed as a general introduction to the geology of Calhoun Bluffs and the surrounding countryside. It is also designed to encourage students to appreciate the effects of the Kansas glacier on this region.

In the Topeka area, the glacier pushed across the Kansas River and up against Burnett's Mound. East of the mound, the ice pushed southward well beyond the area now occupied by Forbes to the edge of the Wakarusa River Valley. West of Burnett's Mound, the Shunganunga Creek served as the southern boundary to the ice flow.

Throughout this area, the glacial drift varies from a few inches on some of the larger hills to over 50 feet in some river valleys.

Answers - Student Self Test Questions

Q-1. What happened to rocks in this area that are 100-200 million years old?

A. Rocks of this age have been eroded and no longer exist.

Note. follow this question with "How old are the rock layers found in this county?" (about 300 million years)
"Are we now depositing or losing layers of rock?" (losing)

Q-2. What has caused Topeka to have a wide variety of rocks in the surface layer of soil?

A. The glacier has deposited quartzite from Iowa, basalt from Canada, agates from around Lake Superior, and rocks from a wide variety of other sources.

Q-3. How did the glacier contribute to our economy?

A. Its primary contribution was a soil rich in minerals and with a good mixture of gravel, sand, silt, and clay. The gemstones are too rare to be of economic importance.

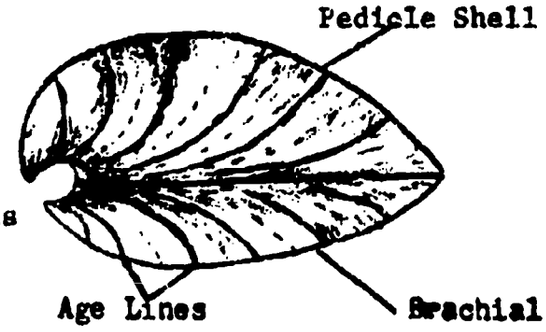
Q-4. Which type of rocks deposited by the glacier is most commonly seen in Topeka?

A. Red quartzite boulders dot yards and can be found in rock walls throughout Topeka. One of the most impressive collections is the wall on the north side of Washburn University.

WHAT IS A FOSSIL? Fossils are traces or remains of ancient plants or animals that have been preserved in the earth's crust by natural means. To be called a fossil, organisms must have been buried before man began keeping historical records. Fossilization of an organism can occur only under conditions that are unfavorable to the life of bacteria. For this reason animals that live in the sea are much more commonly fossilized than those which live on land. Sea animals are more likely to be buried by sediment which forms a protective covering and hinders decay and oxidation.

There are 10 basic kinds of fossils found in the rocks of Calhoun Bluffs. This paper will describe how to identify the fossils and describe the type of animal or plant which probably left the fossil.

1. Brachiopods. Brachiopods are small animals which live only in oceans. They have two shells that are unequal in size and shape. Modern brachiopods are often called lamp shells because they look like the lamps our ancestors used. They feed by sucking water in one side of their body, filtering out small plants and animals, and then blowing the water out the other side. Brachiopods were very common during the Pennsylvanian Period and left many fossils.



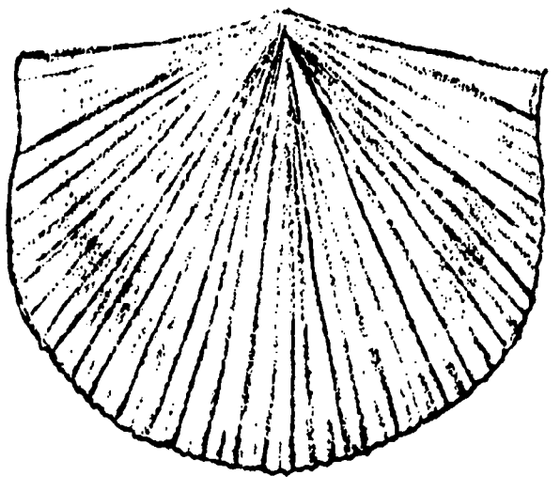
To decide whether or not the fossil is a brachiopod, examine both shells to see if one (the pedicle) is larger than the other (the brachial.)

The pictures below and on the next page illustrate several common brachiopods of the Pennsylvanian Age:

side top (pedicle) hinge end

Neospirifer (3 views)

Juresania 3 views x 1
(Brachial, Pedicle, and Hinge views)



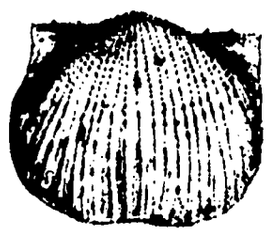
Derbyia, x 1

Wellerella 2 views x 5
Pedicle and Front views

Hustedia, x 3
Pedicle view

Composita, x 1
Brachial view

Lino Productus, x 1
Pedicle view

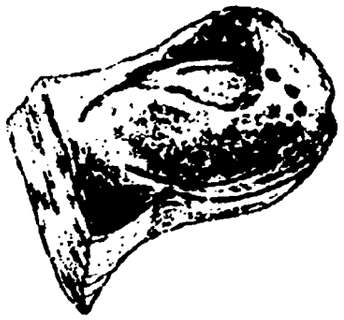


Antiquatonia x ½
Pedicle view

2. Pelecypods. Pelecypods are closely related to brachiopods, and have almost replaced them in today's oceans. The pedicle and brachial shells of the pelecypods are identical, but the right and left sides of each shell are not the same. They are filter feeders who siphon water in one side, filter it, and eject it out the other side as do the brachiopods. Fossils of the animals are rare in the Pennsylvanian rocks. Only one shell of each pelecypod is shown below since the other is identical:

Wilkingia x ½

Septimyalina x 1



Myalina x 1

Aviculopecten x ½

3. Gastropods. Gastropods are commonly called snails. Their shells may be spired, cone-shaped, or even internal as in slugs. These animals feed by licking their food with a tongue equipped with tiny teeth. The tongue-teeth tear off small pieces of material which can then be digested. Fossils of the gastropods can usually be found with careful searching in the Pennsylvanian rocks.

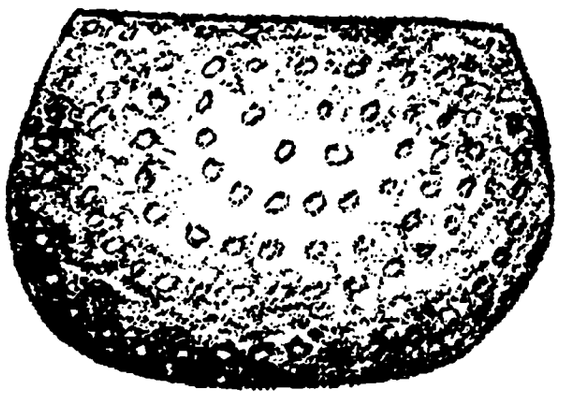
Low-spired gastropod

Hypselentoma x 2
Medium-spired gastropod

Meekospira x 2
High-spired gastropod

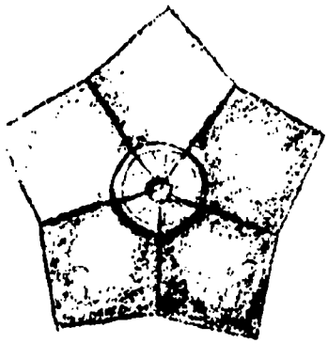
4. Ostracodes. Ostracodes are very small animals with bean-shaped shells enclosing a segmented body with legs and antennae. They shed their shells as they grew and contributed fossils to many of the Pennsylvanian rocks. These animals probably fed on small green plants called algae.

The picture of the ostracode Amphissite has been enlarged 100 times. Its real-life size would be about 7 mm. in diameter.

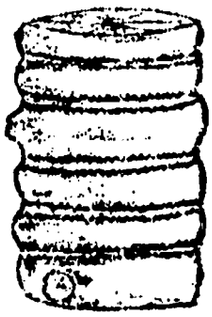


Amphissites x 100

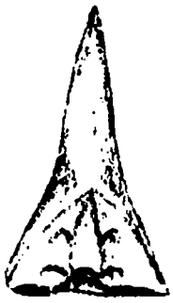
5. Crinoids. Crinoids were small animals with a crown attached to a more or less flexible stem. The crown consists of a cup with attached arms and a small mouth at the base of the arms. This animal remains attached to rocks and other materials with a hold fast, and uses its arms to capture small animals and plants that float by. Its fossils are very common in limestone, but remains of the whole animal can seldom be found. Stem fragments are the most common fossils of this animal.



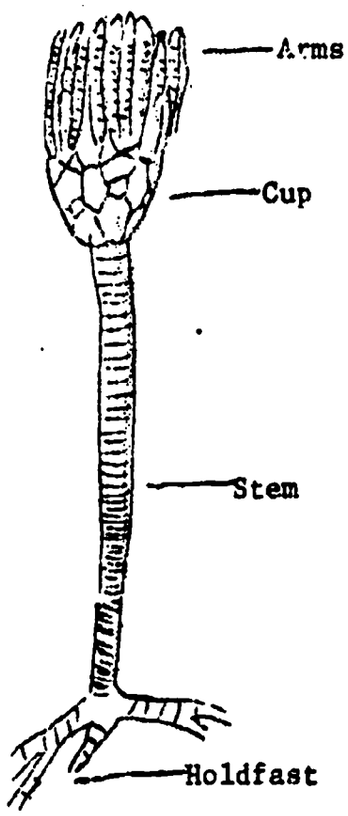
Mouth and Surrounding Plates x 2



Stem Fragment x 1



Armplates x 1



A Typical Crinoid

6. Fusulinids. Fusulinids are single-celled animals which form small shells that look like grains of wheat. Inside the shell are tiny chambers connected by holes. The animal's body can flow back and forth through the holes, and long arms may be extended beyond the body to capture algae and other single-celled animals. Fusulinids were very common in some ancient rocks. They are called "index fossils" because their presence can be nearly positive proof of the age of a rock. Fusulinids are very important to geologists, for they can be brought to the surface by oil wells and easily identified. Thus, layers of rock far beneath the surface can be connected with similar layers hundreds of miles away.

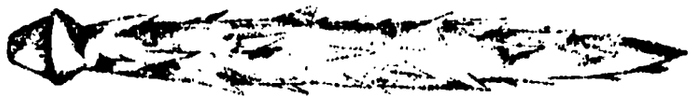
Fusulinid, External View x 10

Fusulinid, Cross Section x 15

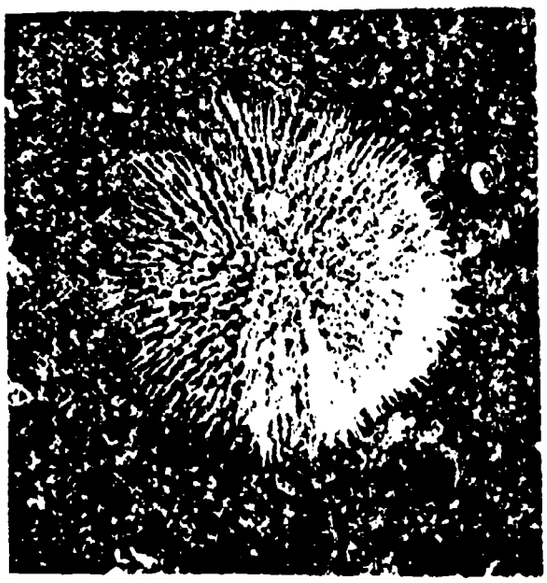
Limestone Containing Fusulinid Fossils x 2

'odule: 2

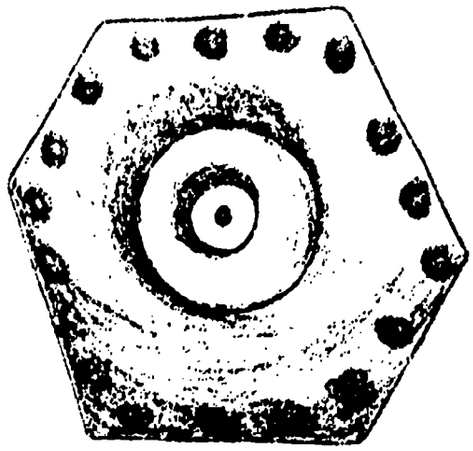
'. Echinoids. Sea urchins are small round animals which use spines to move and ro protect themselves. The spines are connected to a skeleton of six-sided plates buried just beneath the "skin." The spines are quite common in the Pennsylvanian rocks, and the plates may be found with effort and luck. Echinoids feed on small animals and plants which attach to exposed objects in the ocean. Modern echinoids may be found in almost any ocean environment and at all but the greatest depths.



Echinoid Spine x 3

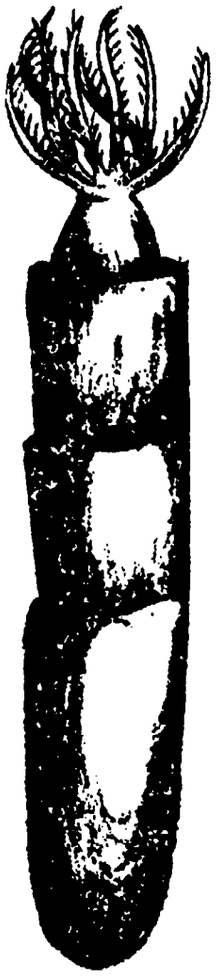


Modern Echinoid

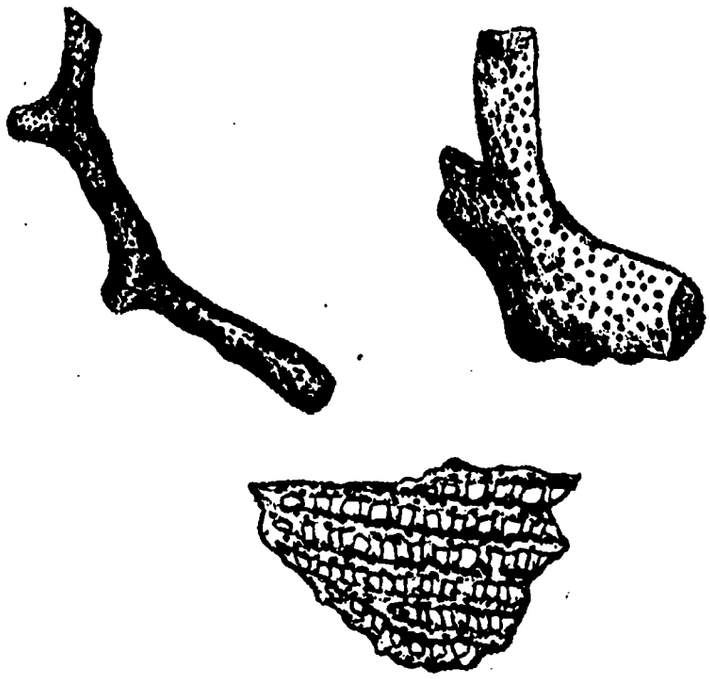


Echinoid x 3

8. Ectoprocts are commonly called moss animals because their colonies look like small clumbs of moss. Modern colonies are made up of tiny animals like those on the next page. Each animal occupies a tiny hole in the "apartment house" deposited by the colony. Several varieties of fossilized ectoproct colonies can be found in the Pennsylvanian rocks.



Idealized
Ectoproct x 50



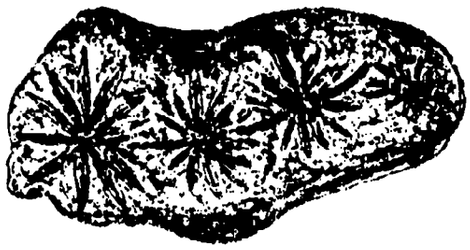
Varieties of Fossilized Ectoproct Colonies x 2

9. Coral. Coral are relatives of jelly fish which make a hard external skeleton. The coral has a mouth surrounded by tentacles equipped with stinging cells. The coral's body extended down into the tubular body through small columns. Horn coral are the most common corals found in Pennsylvanian rocks.

Horn
Coral x 1

10. Plants. Remains of plants are common in the Pennsylvanian rocks, but are very hard to identify. In this area, layers of coal and sandstone both contain small pieces of leaves and stems of long extinct plants. However, these fossil remains are almost always too fragmented to identify. Algae may also have left fossils. These appear as thin mats of material which give some limestones a banded appearance. Some of the Pennsylvanian plant fossils are shown on the next page.

Leaf Frond of Neuropteris x 1



Scouring Rush x 1

Cordaite Leaf x ½

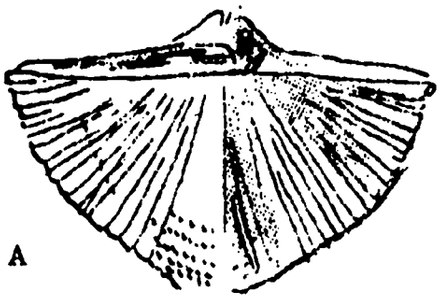
Student Self Test

1) How are brachiopods and pelecypods different? How are they the same?

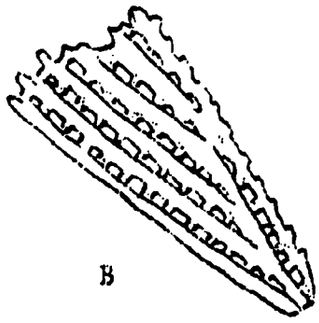
2) Which of the animals described above use tentacles to capture food? Which of these animals are the smallest?

3) Which of the animals described above would usually leave fossils that are less than one-half an inch long?

4) Identify the three fossils shown below and describe how the animal which left them obtained its food.



A



B

x 5

C

5) Which of the fossils described in the paper did not eat animals or plants?

Topics and Concepts

Behavioral Objective Number

7. Given a map of Kansas, students shall be able to select the sections most likely to contain coal.

15. Students shall be able to match the word "crinoid" with a picture of one of its plates.

16. Students shall be able to match a sketch of an ectoproct with a description of its food gathering mechanism.

17. Students shall be able to select a brachiopod from a set of four sketches.

Teacher Suggestions

The purpose of this paper is to help students understand the survival mechanisms used by modern relatives of Pennsylvanian fossils and to develop vocabulary appropriate for the field trip.

One vocabulary change which should be noted--the phylum Bryozoa has been eliminated in most modern texts, and has been replaced by two new phyla--Ectoprocta and Entoprocta. The latter leaves no fossil record in the Pennsylvanian rocks.

Appendix A contains large pictures of the fossils most likely to be found in our field trip. A short "spell down" or game-like drill with these pictures will help students obtain maximum profit from their field trip.

Answers--Student Self Test

Q-1. How are barchiopods and pelecypods different? How are they the same?

A. Brachiopods have two shells (the brachial and pedicle) which are not identical. Pelecypods have two shells which are identical, but neither shell is symmetrical.
Both are alike in that they have two shells and are filter feeders.

Q-2. Which of the animals described above use tentacles to capture food? Which of these animals are the smallest?

A. Crinoids, ectoprocts, and coral all use tentacles to capture food. Of these, the ectoprocts are the smallest animals.

Q-3. Which of the animals described above would usually leave fossils that are less than one-half an inch long?

A. Echinoids, ostracodes, fusulinids, crinoids, and ectoprocts will usually leave fossils which are less than a half-inch long.

0-4. Identify the three fossils shown below and describe how the animal which left them obtained its food.

A. A--Brachiopod obtains its food by filtering water sucked between its shells.

B--Ectoprocts capture small animals and plants with tentacles.

C--Fusulinids extend soft arms of material out of holes in the shell and capture other organisms.

0-5. Which of the fossils described in the paper did not eat animals or plants?

A. The plant fossils. (This would be a good opportunity to point out that plants probably made up over 90% of the total weight of organisms, but left very few remains. Soft bodied animals, such as slugs, jelly fish, and worms, also left very few fossils.

A Geological Description of The Calhoun Bluffs

Paper D gave a quick description of the area surrounding Calhoun Bluffs. Paper E described the kinds of fossils most likely to be found in its rocks. This paper describes those rocks and explains how they were identified.

After reading this paper and doing the exercises assigned by your teacher, you should be able to a) diagram shale, limestone, and sandstone rock layers; b) explain how these layers were laid down; c) figure out which layers of rock contain certain types of fossils; and d) explain how geologists correlate rock layers from one area to another.

The Description

During the Pennsylvanian, 270-330 million years ago, this area of North America was covered with water. During these 60 million years (remember - the United States was established about two hundred years ago) the water slowly changed back and forth between shallow, brackish water to deeper salt water as the ocean advanced and retreated. This slow changing back and forth from deep to shallow water laid down the materials which make the alternating shale and limestone layers that form Calhoun Bluffs today.

Starting with the oldest layers of rock (those at the bottom) and working up, this paper will explain what each layer looks like, what made it, and what fossils are found in it.

The lowest and oldest layer of the rocks exposed at Calhoun Bluffs is the Ervine Creek Limestone. We can see only the upper few feet of this limestone, which must have been formed under a deep ocean. When exposed to weather, this limestone is softer than many kinds and erodes in rounded layers. It contains many Fusulinids, Ectoprocts, Brachiopods, and a few Gastropods.

The sea gradually retreated, and a delta region must have existed for many years as the Calhoun Shale was deposited. This layer of shale received its name because a very good example is found at the Calhoun Bluffs area. Rivers running through the delta left much siltstone and sandstone in old river channels found throughout the Calhoun Shale. This layer has a few fossil Crinoids, Fusulinids, Ectoprocts, and Ostracodes. Plant fossils may be found in its lower beds of siltstone, and thin layers of coal can be found in upper levels.

The sea advanced over the old Delta, and the Hartford Limestone was formed. It is a prominent white limestone that weathers brownish and contains Fusulinids, algae fossils, chambered sponge (found only in this layer), and almost every other kind of fossil found at Calhoun Bluffs. Horn corals can usually be found in the lower level of this limestone.

The sea retreated, and Iowa-Point Shale was formed in a delta. This is a thin layer of shale that has some mica, sandstone and limestone in it. It contains Crinoids, Ectoprocts, and Brachiopods.

The sea advanced again to make the next layer at Calhoun Bluffs. The Curzon Limestone has two to four beds (each bed is slightly different) of bluish-gray to brown, hard limestone. Fusulinids are found in the lower beds with Brachiopods and Ectoprocts in the middle and Osagia Algae occasionally found in the top beds. Crinoids, Echinoid spines, Pelecypods, and Gastropods are found in all beds.

After the sea finally retreated, and the mud flats returned, the Jones Point Shale was laid down. A few fossils are found in this layer, but the most interesting [illegible] to look for are its limestone nodules. These are little pieces of limestone

which, when broken, show small crystals of calcite. This layer is about five feet thick in the Calhoun Bluffs cut.

Sheldon Limestone was then formed below the sea. It is a light gray to white limestone that is fine grained and weathers yellowish to gray. Its shape is smooth and rounded, which is not like the sharp angles of the Curzon Limestone. This bed contains fossil algae, Crinoids, Ectoprocts, Echinoid Spines, Brachiopods, and Gastropods, with a few Fusulinids.

Once again, the ocean retreated, and this time the Turner Creek Shale was formed. This layer contains some claystone, siltstone, and limestone beds in it, as well as the shale from which it gets its name. It has Crinoid, Pelecypod, Brachiopod, and occasionally, Ostracode fossils.

The next layer is a thin layer of DuBois Limestone, which is a dark blue to green stone when fresh, but it also weathers to a brown color. This layer contains about every type of fossil found at Calhoun Bluffs.

The highest rock layer in this area is the Holt Shale layer. It is a bluish-gray to black shale about 290 million years old. It contains fossilized Brachiopods, Ectoprocts, and Pelecypods.

The top soil on top of Calhoun Bluffs is less than one million years old. It contains pieces of rocks, such as granite and quartzite, brought down by the Kansas glacier.

The rock layers between one million and 290 million years are gone from this part of Kansas. They were removed by the glaciers, by erosion from rivers and wind, and some may have never been deposited.

Student Self Test

1. What conditions lead to the formation of shale?

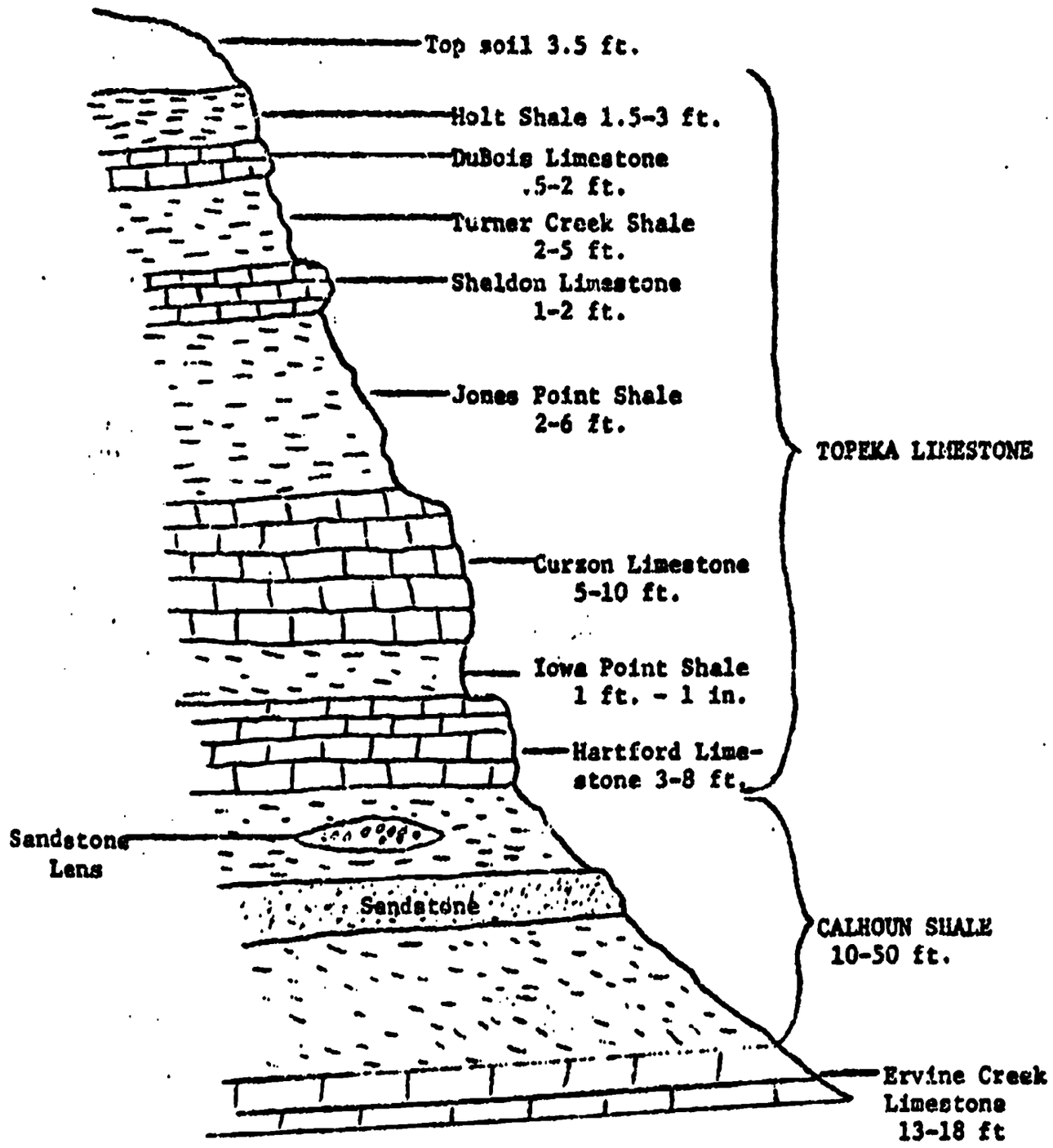
2. What conditions lead to the formation of limestone?

3. Which layer is the thickest in Calhoun Bluffs?

4. Fill in the work sheet for pages D-4 and D-5 provided by your teacher. Which layers have fossils found in no other layers in Calhoun Bluffs? Which layers have a rich assortment of almost every kind of fossil?

5. Describe in your own words the procedure used to decide if Calhoun Shale and Hartford Limestone are found in another area, such as Emporia, Kansas or Lincoln Nebraska.

The Topeka Limestone and Upper Portion of Deer Creek Limestone
of the
Shawnee Group at Calhoun Bluffs



This diagram shows the members of the Topeka Formation and Calhoun Formations as you would see them when stopping at the road cut through the Calhoun Bluffs east of Topeka.

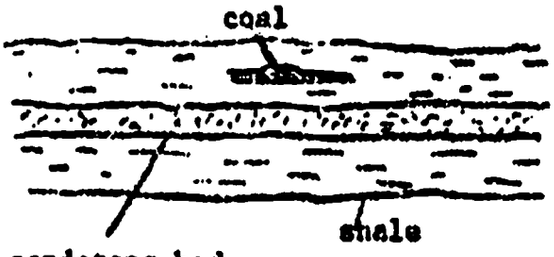
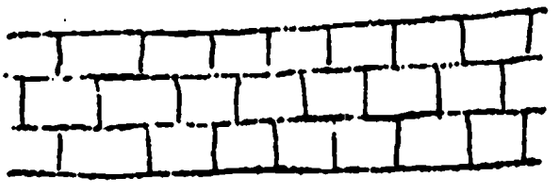
Module: 2

Name_____

Circle the fossils and sketch the rock layers described as you read the paper about Calhoun Bluffs. The Calhoun Shale is done for you to use as an example, since its sketch is pretty complicated.

Rock Sketch	Name	Fossils and Other
	Top Soil	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Holt Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	DuBois Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Turner Creek Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	Sheldon Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Jones Point Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	Curzon Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____

Module: 2

Rock Sketch	Name	Fossils and Other
	Iowa Point Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Hartford Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
 sandstone bed	Calhoun Shale layer (showing beds of coal and sandstone)	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other Coal beds
	Ervine Creek Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____

Topics and Concepts

Behavioral Objective Number

6. Given a map of Kansas divided into five sections, students shall be able to select the sections most likely to contain coal.

12. Students shall indicate that rocks (other than glacial) deposited less than 290 million years ago have eroded from Shawnee County.

18. Students shall select the type of habitat responsible for depositing the material in limestone rocks.

19. Students shall select the habitat responsible for depositing the material in shale rocks.

20. Given an unlabeled cross-sectional sketch of an area similar to Calhoun Bluffs, students shall be able to identify the limestone layer.

21. Given the sketch described above, students shall be able to identify the shale layer.

22. Given four separate cross sections of rock layers which can be correlated, students shall be able to select the oldest and youngest layers of rock.

Teacher Suggestions

Duplicate papers F-7 and F-8 and have the students fill in the sketches and note the fossils they should expect to find in each layer. If students bring these papers on the field trip, they will help direct attention to unique fossils found in the various layers.

Following this exercise, use the Transparencies found in Appendix B in the following manner:

Show Transparency 1 and point out that sequences 1 and 4 belong to two rock outcrops found 100 km apart, and not necessarily at the relative elevations shown. Explain that they are to make a geologic correlation of these two outcrops from the information presented in the visual. Their goal will be to determine if the layered rocks in the two outcrops belong to the same sequence of deposition. Have your students identify each rock type by name, using the key at the lower left.

Suggested Questions and Possible Answers

1. Which bed in sequence I is the youngest? Why? (Conglomerate. In an undisturbed sequence, the youngest rock is at the top.)

2. Which bed in sequence I is the oldest. Why? (Gray limestone. In an undisturbed sequence, the oldest rock is at the bottom.)

3. Which bed in sequence IV is the oldest? Which is the youngest? (The oldest is limestone with fossils. The youngest is red shale.)

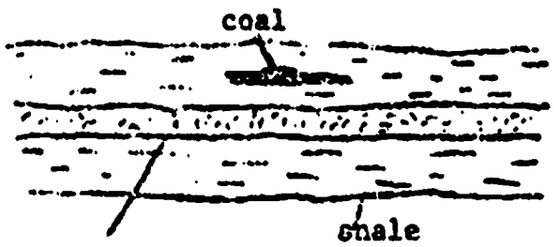
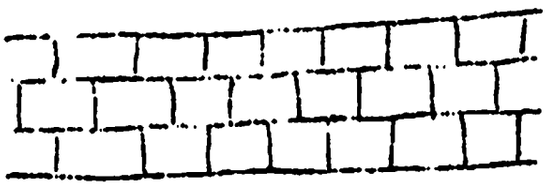
Module: 2

Name_____

Circle the fossils and sketch the rock layers described as you read the paper about Calhoun Bluffs. The Calhoun Shale is done for you to use as an example, since its sketch is pretty complicated.

Rock Sketch	Name	Fossils and Other
	Top Soil	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Holt Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	DuBois Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Turner Creek Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	Sheldon Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Jones Point Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Others_____
	Curzon Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____

Module: 2

Rock Sketch	Name	Fossils and Other
	Iowa Point Shale	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Hartford Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____
	Calhoun Shale layer (showing beds of coal and sandstone)	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other Coal beds
	Ervine Creek Limestone	Brachiopods, Gastropods, Pelecypods, Echinoids, Ostracodes, Fusulinids, Crinoids, Bryozoans, Coral Other_____

4. Do sequences I and IV have any layers in common? (No.)

5. Can you correlate, or match, the two sequences from what you now know? (No.)

Place Page 2 on Page 1. Sequences 2 and 3, although located between 1 and 4, are again not necessarily shown at their proper elevations. You might stress to your students that they must consider the elevations of the four sequences to be flexible (the sequences may have been shifted or even bent or warped, for example) in order to correlate them through beds common to several sequences.

Suggested Questions and Possible Answers

1. Which is the youngest rock in sequence 2? Which is the oldest? (The youngest is gray limestone. The oldest is limestone with fossils.)

2. Which is the youngest rock in sequence 3? Which is the oldest? (The youngest is conglomerate. The oldest is chalk.)

3. What rocks do sequences 1 and 2 have in common? (Gray limestone.)

4. What rocks do sequences 1 and 3 have in common? (Both contain gray limestone overlain by conglomerate.)

5. What rocks do sequences 2 and 4 have in common? (Sequence 2 contains all the layers found in sequence 4 in exactly the same order. However, sequence 2 contains one layer more than sequence 4.)

6. What rocks do sequences 3 and 4 have in common? (Both contain chalk overlain by red shale.)

7. What rocks do sequences 2 and 3 have in common? (Both contain the series chalk, red shale, and gray limestone.)

8. How can you use the beds common to sequences 2 and 3 to correlate sequences 1 and 4? (Since sequences 1 and 3 both contain gray limestone overlain by by conglomerate, they can be correlated directly. Sequences 2 and 4 can be correlated because in both of them limestone with fossils, green sandstone, dolomite, chalk, and red shale occur in exactly the same order. Sequences 2 and 3 can be correlated from their common sequence of chalk overlain by red shale and gray limestone. This process now makes it possible finally to correlate sequence 1 with sequence 4, even though no one rock layer is common to both. (Students may arrive at this correlation through a different series of steps. An alternate procedure, for example, is to note that chalk overlain by red shale is common to and relates sequences 2, 3, and 4. When 3 and 1 are correlated through their common layers, it becomes possible to correlate 1 and 4.)

9. Beginning with the oldest, list the rocks in the order of their formation. (Limestone with fossils, green sandstone, dolomite, chalk, red shale, gray limestone, conglomerate, gray sandstone, gray shale, red sandstone, and conglomerate.

Remove page 1 and 2. Show page 3. Have students check their answers to the previous series of questions. You may wish to discuss areas of difficulty with them at this time, contrasting the method of correlation used here with that actually used by geologists. Unlike the students, the geologist in the field will be aware of the relative vertical locations of two or more similar beds of rock in different outcrops. Unfortunately, however, the field geologist does not

usually encounter the ideal situation shown in this visual. Here the beds have not been disturbed or deformed since the rocks were formed, and they continue without interruption for some distance. In nature, layers of rock may gradually thin out and disappear, or they may simply be missing. For example, the same deposit of shale may overlie sandstone and limestone at one spot and only limestone at another, perhaps because the sandstone at the second place was removed by erosion or was not part of the original sequence of deposition.

Answers - Student Self Test Questions

Q-1. What conditions lead to the formation of shale?

A. A shallow, brackish swamp or lake.

Q-2. What conditions lead to the formation of limestone?

A. A deep ocean.

Q-3. Which layer is the thickest in Calhoun Bluffs?

A. Calhoun shale is by far the thickest member in the series. It is about 50 feet thick where we will be working.

Q-4. Fill in the work sheet for pages D-4 and D-5 provided by your teacher. Which layers have fossils found in no other layers in Calhoun Bluffs? Which layers have a rich assortment of almost every kind of fossil?

A. Calhoun shale has plant fossils found in none of the other layers. Hartford limestone contains chambered sponge (and Horned Coral is almost never found elsewhere.) Curzon Limestone, Sheldon Limestone, and DuBois Limestone contain nearly all types of the fossils which can be found at Calhoun Bluffs (with the exception of the two listed above.)

Q-5. Describe in your own words the procedure used to decide if Calhoun Shale and Hartford Limestone are found in another area, such as Emporia, Kansas or Lincoln, Nebraska.

A. Students should have a good grasp of these points.

1) Each rock layer in the section is carefully examined and measured.
2) The physical descriptions of the rocks are made, and fossils contained in it are noted.
3) Geologists then attempt to align the sections so that rock layers with similiar characteristics occur in identical sequences.
4) If the alignment can not be made, then sections closer together must be examined to determine layers which may have been removed by erosion or never deposited over the distance between the two original sections.

Does Geology Really Affect Us?

Geology helped determine Topeka's location. The original settlers chose Topeka for their home for three reasons: the Kansas River (at that time) could be used to ship supplies to and from the east; the Kansas River Valley is one of the most fertile valleys in the nation; and the river had low banks and was easily crossed near Topeka. This created a natural flow of wagon traffic toward Topeka.

All of these conditions were created through geological events happening long before man arrived in Kansas. The wide, deep river channel was cut, in part, by water rushing east from glaciers melting thousands of years ago. The fertile valley soil was produced by erosion of soil and rock in Western Kansas and by material left from glaciers. The low river banks near Topeka were caused by a hard layer of rock which could not be cut deeply. This rock lays beneath the river bed and causes the river to widen, rather than deepen near Topeka.

The activities of the glaciers still influence building activities near Topeka. Homes with basements will cost much more to build if their owner chooses a hill of glacial debris for his homesite. Boulders the size of a room may lie just beneath the soil in some areas of Topeka. A road builder nearly destroyed his business when one highway was being built near Topeka. He had not seen that he would be required to build much of the road through hills of glacial debris that could not be blasted apart and were made of giant boulders packed in gravel and hard clays. The price he had bid to build the highway did not cover his costs.

The limestone layers beneath our county also have a strong influence on the building industry. To easily build basements and to lay sewer lines deep enough to avoid freezing, the upper rock layers must be at least 12 feet below the surface of the soil. Many hillsides within Topeka lie vacant because builders were unable to economically construct homes on the property they purchased.

Limestone also helps builders. Its hard, white surface can be seen in homes, fences, and retaining walls throughout our area. Limestone has even helped to create most of the hills throughout our county. Long ago, when streams were cutting their valleys, layers of particularly hard limestone were encountered. The rivers often cut around, rather than through, these harder layers. Hills were formed beneath the protective limestone as the water cut away surrounding rocks and soils.

Clay produced from the shale layers in our rocks is also important to Topekans. The clay once supplied the material for a very large brick industry. Ceramics, pottery, and some bricks are still made using the clay exposed throughout our county.

The same clay that was so useful for brick production hurts thousands of home owners throughout the county each year. Homes built in heavy clay layers will have continual problems with basement flooding, as the clay expands and contracts around the foundation of their home. The clay often conducts water to the edge of the basement and may form a water jacket around the basement after each prolonged rain.

Septic tanks of homes built on heavy clay will not work as intended. The clay does not allow the water to move down and through the soil. Instead, the sewage water creates soft spots and open, polluted puddles of water in low areas near the home. This problem is particularly bad in suburbs built north of the Kansas River.

Coal from the Nodaway coal bed was used to heat the homes of Topekans during the 19th century, but no mining activity has been reported since 1927. Strip pits and shaft mines were used in what is now called Gage Park and along Shunganunga Creek in the southwestern corner of Topeka. The large water fowl area in the park covers one of the largest shaft mines in the county. The coal was from a high quality bituminous bed of about one foot in thickness.

Sand and gravel is produced from the sandy soil along the Kansas River and from several quarries south of the river. The sand and gravel is used for building, paving, and roadfill. Most of this material was brought to Topeka by the Kansas glacier.

Finally, geology of this area has supplied a rewarding hobby to hundreds of rock hunters. Agates and other beautiful rocks can be found among the glacial till in our county. Those interested in this hobby have formed a large and thriving organization of rock hounds.

STUDENT SELF-TEST

1) How have glaciers affected man's activities in our county?

2) How can limestone layers hurt our building industry? How can they help it?

3) List one useful and one harmful property of shale.

4) The Nodaway coal bed was found near the surface in western Topeka. You have studied the rocks exposed east of Topeka. Would you expect to find the Nodaway coal <u>beneath</u> the Calhoun Bluffs rocks, or <u>eroded</u> from their surface? Why?

Behavioral Objective Number	Topics and Concepts
6	Students shall be able to select the areas of Kansas most likely to contain coal in rock layers near the surface.
11	Students shall indicate that more material is now being lost through erosion than is gained through deposition in Kansas.
23	Given a cross-sectional sketch of a cliff, students shall be able to select the bed of rocks best suited for building material.
24, 25	Given a set of four descriptions of the upper 10 feet of soil and rock, students shall be able to pick the conditions most likely to cause two specific problems with home construction.

Teacher Suggestions

This paper serves only as a very quick overview of the relationship between geology and urban planning. Should you wish to go into more depth, the environmental education project has two excellent sources - "A Pilot Study of Land Use Planning and Environmental Geology" published by the State Geological Survey of Kansas; and "Environmental Planning and Geology" by the U.S.Department of Housing and Urban Development.

Answers - Student Self Test

Q-1. How have glaciers affected man's activities in our county?

A. Glaciers have deposited large boulders beneath the surface of much of the county, have left behind sand and gravel important to the building industry, and have left much of the high quality farming soil in the county.

Q-2. How can limestone layers hurt our building industry? How can they help it?

A. Limestone beds too near the surface can make the cost of building basements and laying water lines prohibitively expensive. People who buy undeveloped plots of land with the intention of building homes frequently get caught by this problem, and students should be aware of its existence.

They help the building industry directly as limestone "bricks" for many buildings and landscape purposes and, when processed, as a key ingredient in cement.

Q-3. List one useful and one harmful property of shale.

A. Shale is useful as the main ingredient in making bricks. It also breaks down to form soil, and provides a good cushion between home foundations and solid limestone layers.

Its main disadvantage is that it forms clay, which provides a poor support for dry and unreinforced basements. Clay shrinks and swells to such an extent that concrete block walls or poorly built walls will crack. Then, water will seep through the cracks to create a damp basement.

Q-4. The Nodaway coal bed was found near the surface in western Topeka. You have studied the rocks exposed east of Topeka. Would you expect to find the Nodaway coal <u>beneath</u> the Calhoun Bluffs rocks, or <u>eroded</u> from their surface? Why?

A. Nodaway coal lies about 40 feet above Holt Shale, the top member of the Calhoun Bluff sequence. Coal Creek Limestone (4.5 feet) lies above the Holt Shale, and Severy Shale (30-50 feet) lies above the Limestone. The Nodaway coal bed lies in the upper portion of the Severy Shale.

Students should have been able to predict that the coal has eroded from the Calhoun Bluff surface since it is mined near the land's surface west of the Bluffs. Since the rock layers slope down to the west, surface layers to the east are almost always beneath those to the west.

Use this opportunity to re-emphasize that almost all exposed surfaces loose more material than they gain, and that millions of pounds of coal and oil have been lost as rocks have eroded over the past hundreds of millions of years. More rocks will probably not be deposited in Kansas until its elevation has been lowered by 1000 feet.

The Field Trip

Topics and Concepts

Behavioral objectives 4 - 25 will all be reviewed during the trip. In addition, the objectives below will be introduced and taught.

26. Given a sketch of rock layers on one side of a slump, students shall be able to select the best explanation of the cause.

27.-
29. Students shall correctly identify labled specimens of limestone, shale and Echinoid fossils.

Using Field Trip Forms

"Request to Principal for Field Trip" form

Three copies of this form must be submitted for each field trip. They should be submitted as early as possible and at least one week prior to the trip. You may use the form on page H-2 in either of two ways: duplicate it the proper number of times, fill in the required information, and turn in to your principal; or obtain the proper number of request forms from your principal and transfer this information to it.

Please invite your principals to attend this trip with you. It will provide them a much better picture of the value of field trips than could be conveyed in any number of words.

"Parental Permission" forms

Duplicate page H-3, and strongly urge your students to have their parents read and sign these sheets. They are quite important to the continued success of this project and in establishing some communication from you to the parents. We need the volunteers that are occasionally picked up with this form, and the community should be aware of what the project and its teachers are doing with their students. We also need the emergency phone numbers in case a student should be hurt.

Have the class fill out the first three blank lines before sending the forms home. Please bring the forms with you when boarding the bus.

Geology Work Sheet

Duplicate one copy of this form (pages H-5 and H-6) for each student if you wish to have it used on the field trip. Notify the project of your intention to use, or not use, this work sheet at least one day prior to the trip.

Module: 2

THE TOPEKA PUBLIC SCHOOLS
REQUEST TO PRINCIPAL FOR FIELD TRIP
Secondary Schools

Community resources are valuable aids to the instructional program. Careful planning and proper follow-up are necessary in order to make the trip most worthwhile. This form should be properly completed in TRIPLICATE and signed by the teacher and principal. The original copy is filed in the principal's office. The principal shall send duplicates to the office of instruction and departmental supervisor.

School__________ Department Science Subject and Class__________

Date of Trip________ Leave______ Return______ Number of Pupils______

Description of Trip The class will travel to the Calhoun Bluffs north of Topeka on Highway 24 for a three-hour field trip. The trip will have one trained adult guide for every eight students.

Objectives of the Trip To relate concepts developed during the pre-trip and post-trip study of geology to the surrounding environment of Shawnee County. The trip will include fossil hunting, rock identification, and rock column analysis.

Means of Transportation Environmental Education bus.

Required Student Cost none

Teacher Signature________________ Date________

- -

I approve the above request and accept the responsibility for the field trip as stated in the guidelines on the reverse side.

Principal's Signature________________ Date________

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project
Phone: 357-0351, Extension 28

The_____school science students in_____class will be participating in a three-hour field trip to Calhoun Bluffs on_____. Transportation and volunteer leaders for the trip will be supplied by the Outdoor Environmental Education Project. Students should wear durable, washable clothing and stout shoes.

If you give_____permission to take this trip, please answer the following questions, and give your signature below.

_____
Signature of Parent

Emergency Information:

Home Phone_____

Alternate Phone_____

Doctor's Name_____

Doctor's Phone_____

- -

The Outdoor Environmental Education Project takes students from all over Topeka on many different kinds of field trips. If you would be interested in serving as a volunteer to lead students on any of our trips, please indicate your interests below. You would be trained for any trip before being put in charge of a small group of students. You are also welcome to visit any trip if you so desire.

With training, I could help lead a field trip. ☐ Yes ☐ No

I would like to work with: Sixth Graders ☐ Junior High ☐
Senior High ☐

I would like to help on these types of trips:

Museums ☐ Woodlands ☐ Nature Study (Sixth Grade) ☐

Geology ☐ Industry ☐ Laboratories ☐

Name_____

Address_____

Planning for the Substitute

The substitute provided by our project is able to present Papers D, E, F, and G. Provide the substitute with lesson plans for each class which would allow her to present meaningful and interesting material.

Notify both the substitute and the students of the various discipline tools at her disposal, for many classes prefer to harass rather than learn from a substitute.

Pre-trip Lecture Suggestions

1. Remind students where they will meet the bus and the time for departure and return to the school.

2. Students will be climbing up and down steep slopes with much shale for two hours. They should wear durable pants and comfortable old walking shoes.

3. Eat a nutritious breakfast and (in case of afternoon trips) lunch. Students with inadequate meals tire out quickly, and grumbling stomachs provide strong competition for constructive learning.

4. Behavior during the trip: a) Groups may be assigned or selected at random by the staff. b) The trip is an intensive learning experience, so come prepared to work and learn. c) No horseplay is allowed. The rocks and steep slopes are too dangerous to allow inattentive behavior. The guides are under strict orders to terminate the trip after issuing one warning. Students will not be allowed to endanger themselves or others.

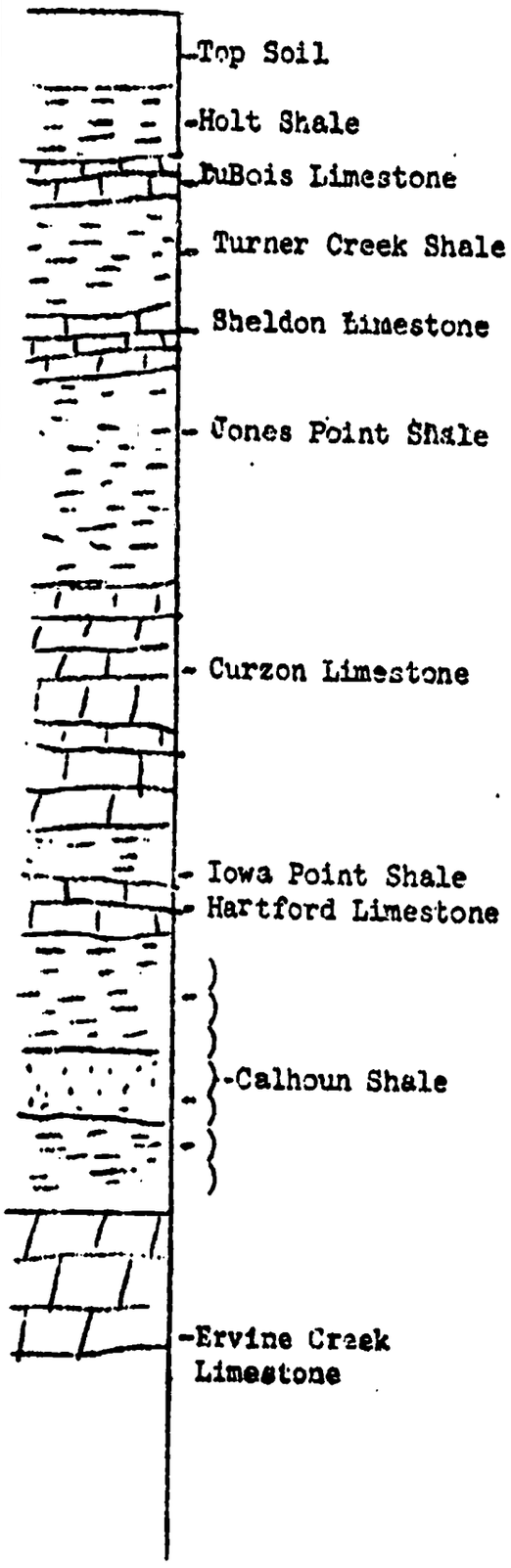
Field Trip Time Line

The trip requires a full three hours to reach every objective. If less than that time is available, portions of the trip will be trimmed from the agenda.

Travel to Calhoun Bluffs and disembarking time. . . . . 30 minutes
Tour of the area. . . . . 2 hours
Travel to the school and disembarking time. . . . . 30 minutes

Name_____

GEOLOGY WORK SHEET



Site A

1) What layers are you working in?

2) Circle the fossils you find in these layers.

Brachiopods, Gastropods, Pelecypods,

Echinoids, Fusulinids, Crinoids, Bryozoans,

Coral Other_____

Site B

1) What layers are you working in?

2) Circle the fossils you find in these layers.

Brachiopods, Gastropods, Pelecypods,

Echinoids, Fusulinids, Crinoids, Bryozoans,

Coral Other_____

Site C

Identify samples of rocks or minerals in this area. Indicate how each rock was made and why you were able to find it in this area.

Basalt_____

Calcite_____

Coal_____

Hematite_____

Limestone_____

Limonite_____

Quartz_____

Quartzite_____

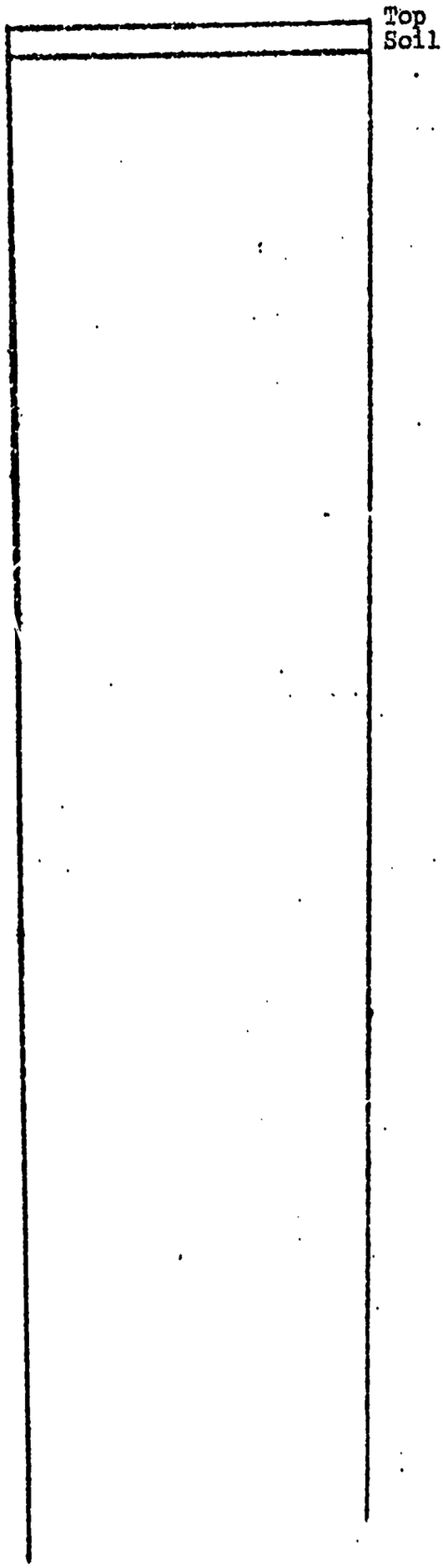
Sandstone_____

Shale_____

Geology Work Sheet

Site D

Examine the rock layers of the hill in front of you. In the column below, indicate which layers are shale, sandstone, or limestone, and how thick each layer is.



Site E

As you move up the hill that you just sketched, check to see if your guesses about the types of rocks were correct.

Do you see any evidence that rocks in this area have changed position from their original level beds? List your evidence and suggest two possible causes.

Circle the kinds of fossils you found in this area.

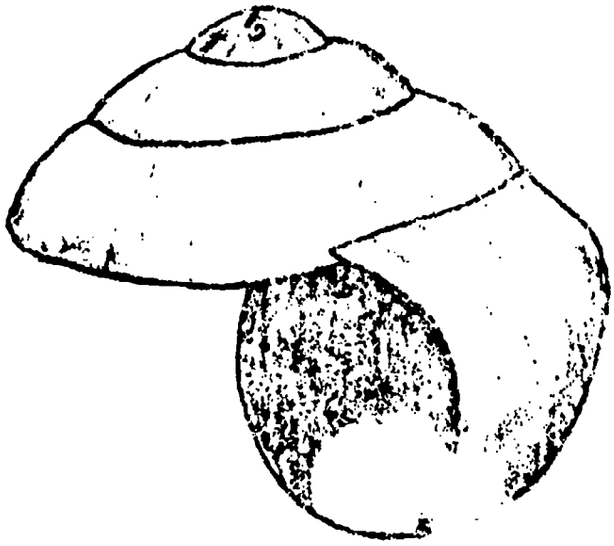
Brachiopods, Gastropods, Pelecypods,

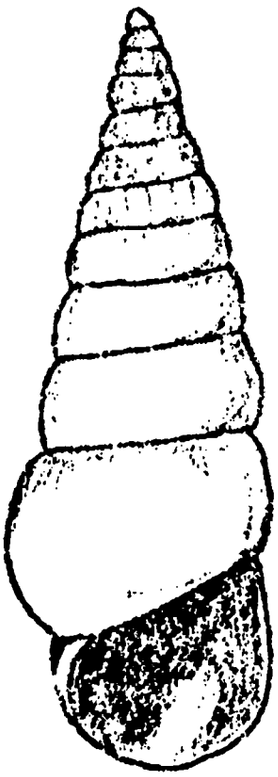
Echinoids, Fusulinids, Crinoids,

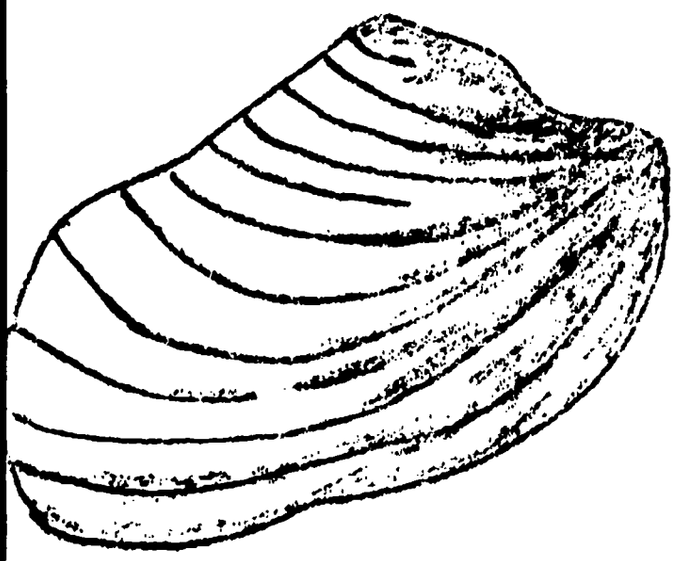
Bryozoans, Coral

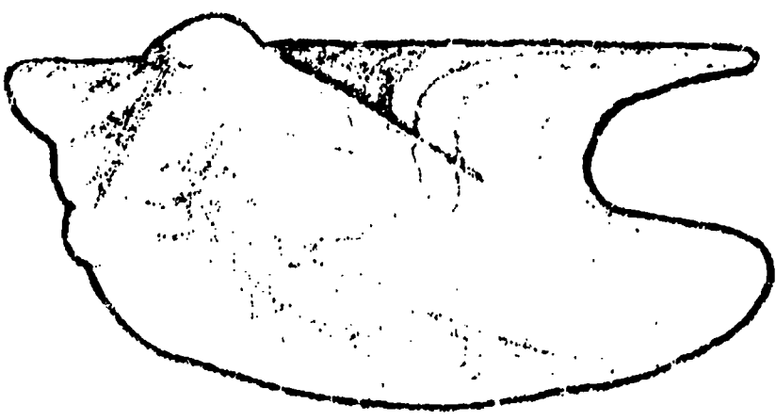
Other_____

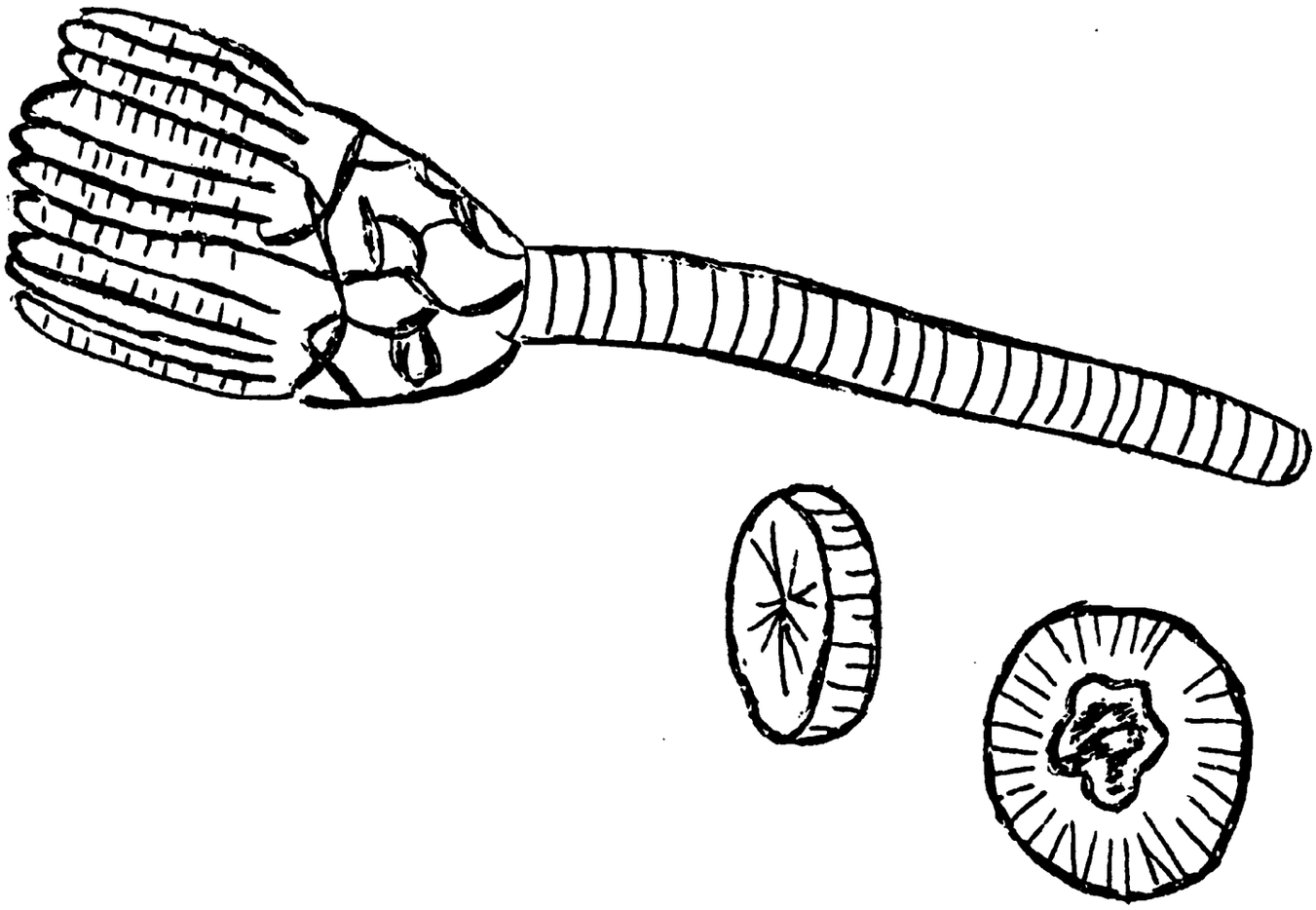
Appendix A

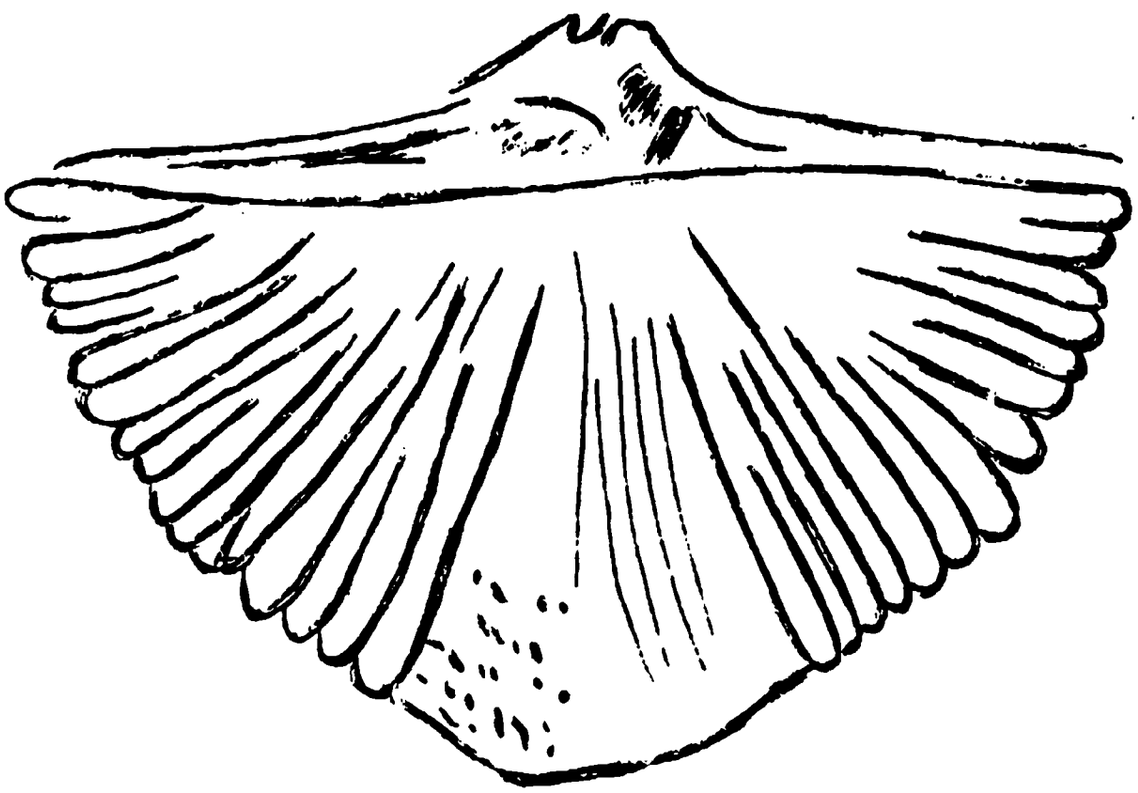


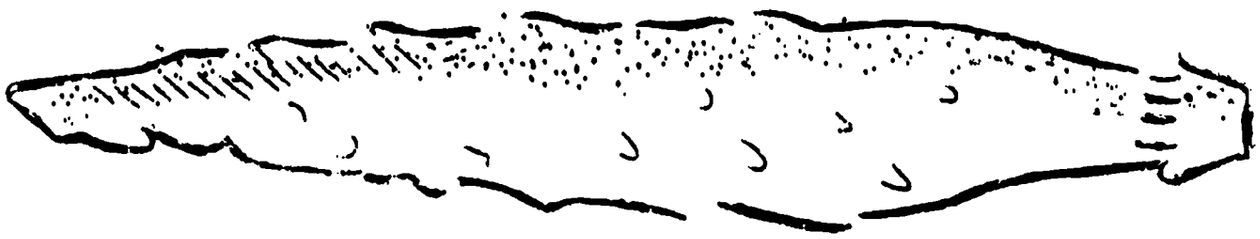


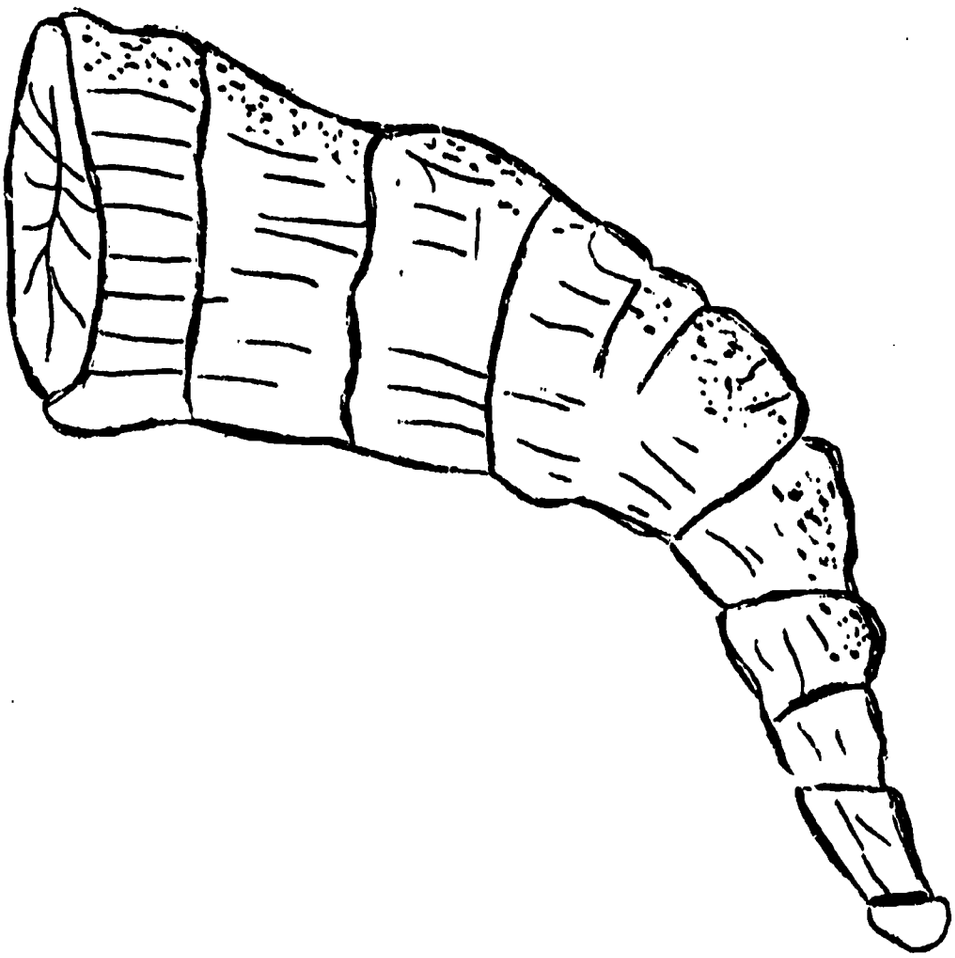


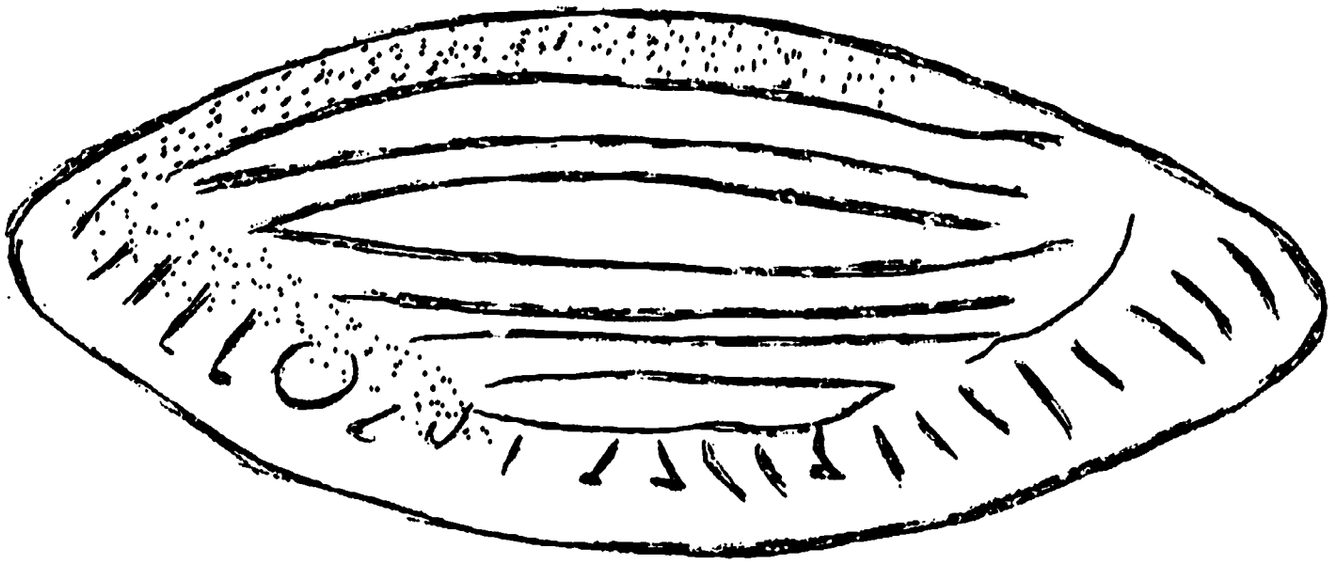


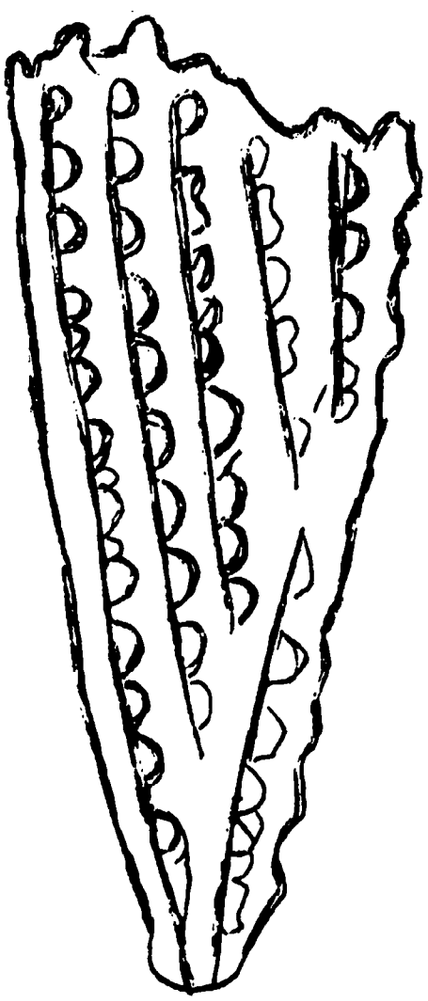






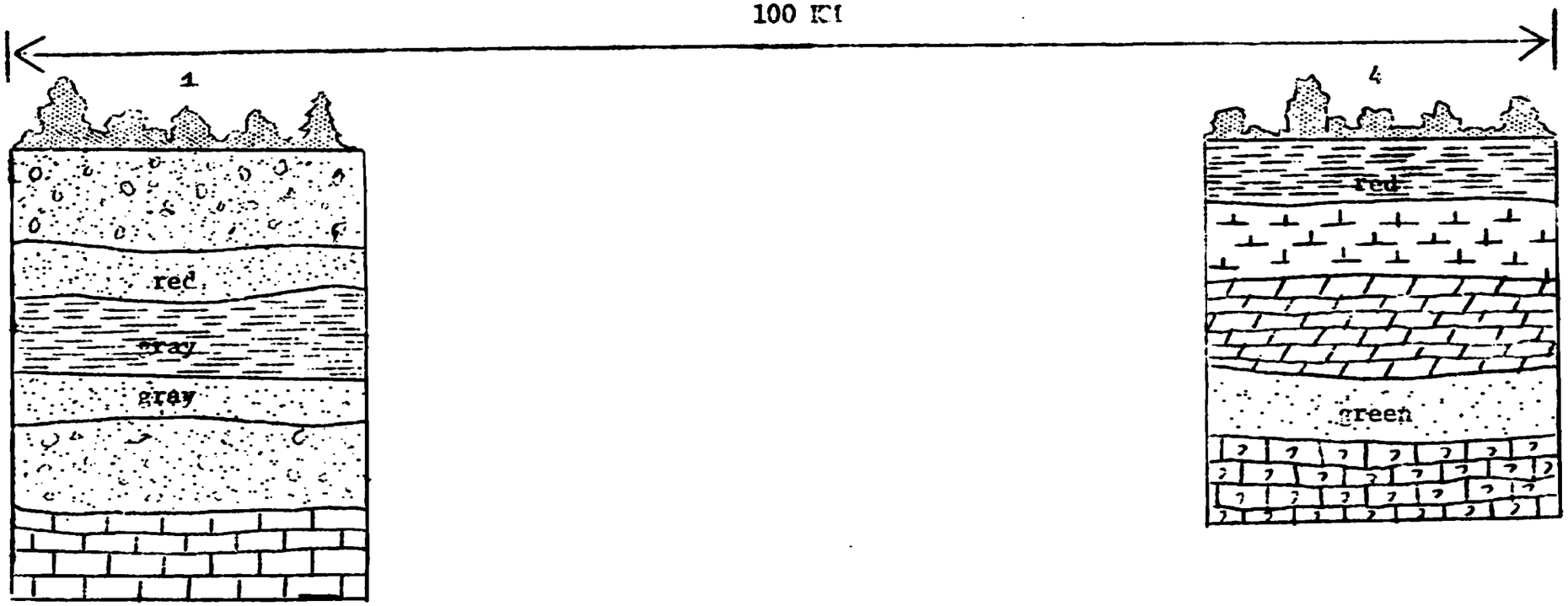






APPENDIX B

Module 2



Chalk

Conglomerate

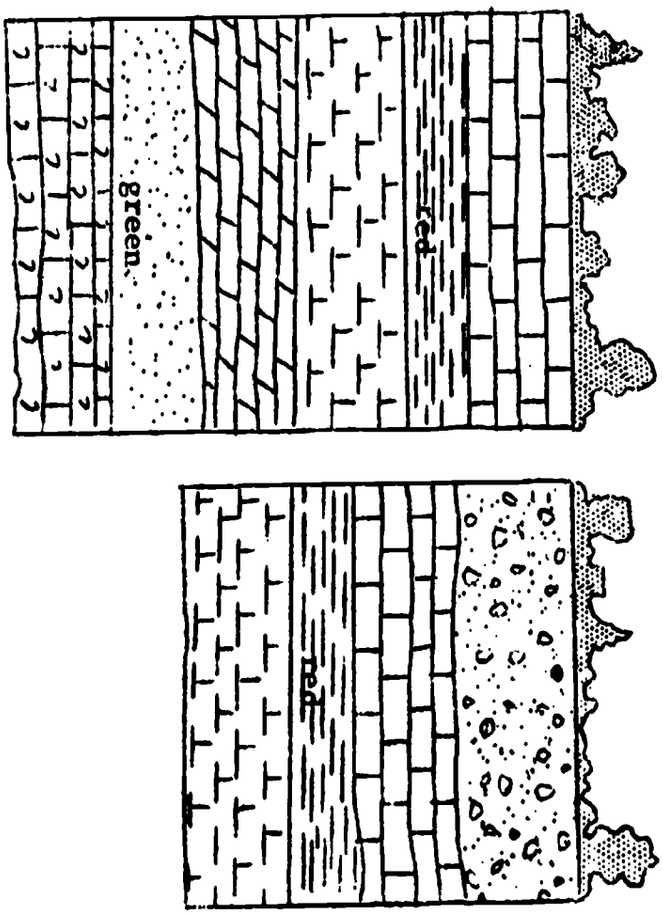
Dolomite

Limestone

Limestone with fossils

Shale
- red
- gray

Sandstone
- red
- green
- gray



APPENDIX B